

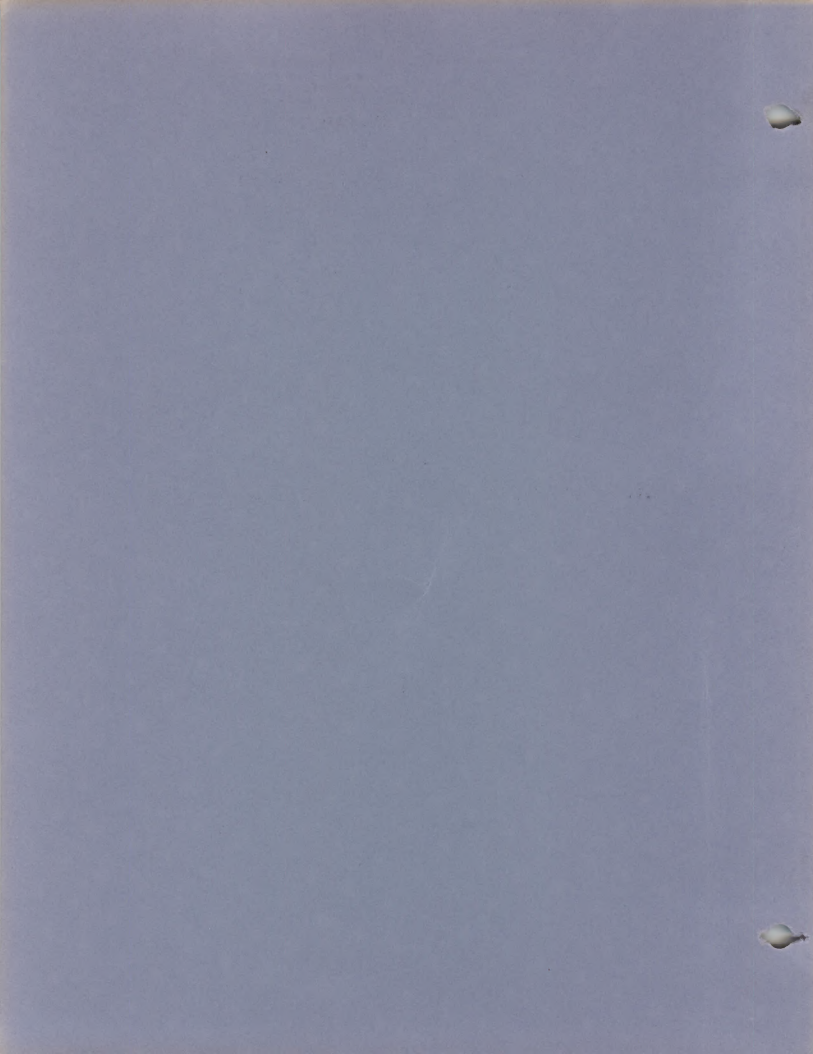
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

EXAMPLES OF GOOD PRACTICE

OBSERVATIONS
FOR
TIME, LATITUDE, AND AZIMUTH
WITH
REDUCTIONS AND RELATED CALCULATIONS

Washington, D. C.
Reprint of 1957

CALIFORNIA STATE OFFICE
CENTRAL LIBRARY COPY





UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

TA
622
E985
1970b

Foreword

This is a reprint of the publication first issued in April, 1946, by the former General Land Office, a predecessor of the Bureau of Land Management. It is reissued to meet the needs of the field cadastral surveying personnel who have found these Examples of Good Practice valuable for reference and as a guide in the making of similar observations.

The original publication resulted from a recommendation of the Board on Technical Procedures of the General Land Office to the effect that special examples of good practice in particular phases of the work be assembled and distributed for the benefit of the entire cadastral surveying service for reference and use in similar cases. There are included herein examples of basic methods for determination of time, latitude, and azimuth by observation of the sun, Polaris, and selected bright stars within the equatorial belt.

The recorded observations were made by cadastral engineers in the execution of their regular field assignments in the survey and resurvey of the public lands. The examples illustrate the approved methods described in the Manual of Instructions for the Survey of the Public Lands of the United States, edition of 1947. The basic astronomical data are as supplied in the Ephemeris, published annually by this Bureau.

INDEX

All observations made with the General
Land Office one-minute solar transit

Manual Section	Example	BASIC OBSERVATIONS	Page
68	A - 1	Daylight stellar altitude observation, equatorial belt, for time and azimuth; shows derivation of the finding position	2
	A - 2	Sunset stellar altitude observation; ditto	4
	A - 3	Sunrise stellar altitude observation; ditto	6
	A - 4	Evening stellar altitude observation; ditto	8
70	B - 1	Altitude observation of the sun for time	9
	B - 2	Evening stellar altitude observation for time	10
71	C - 1	Meridian observation of the sun for time	12
	C - 2	Ditto	13
	C - 3	Evening stellar meridian observation for time	14
	C - 4	Ditto	15
74	D - 1	Meridian altitude observation of the sun for latitude	16
	D - 2	Ditto	17
75	E - 1	Meridian observation of the sun for time and latitude	18
	E - 2	Ditto	19
	E - 3	Evening stellar meridian observation for time and latitude	20
	E - 4	Ditto	21
76	F - 1	Altitude observation of Polaris at upper culmination for latitude	22
	F - 2	Ditto	23
76	G - 1	Sunrise hour angle altitude observation of Polaris for altitude	24
	G - 2	Ditto	26
AZIMUTH			
67	H - 1	Polaris at elongation, observing program "a"	28
	H - 2	Ditto	29
	H - 3	Ditto	30

All specimens were sent to the
Smithsonian Institution for analysis

Page	Figure	Figure
2	Fig. 1	Fig. 1
4	Fig. 2	Fig. 2
6	Fig. 3	Fig. 3
8	Fig. 4	Fig. 4
10	Fig. 5	Fig. 5
12	Fig. 6	Fig. 6
14	Fig. 7	Fig. 7
16	Fig. 8	Fig. 8
18	Fig. 9	Fig. 9
20	Fig. 10	Fig. 10
22	Fig. 11	Fig. 11
24	Fig. 12	Fig. 12
26	Fig. 13	Fig. 13
28	Fig. 14	Fig. 14
30	Fig. 15	Fig. 15
32	Fig. 16	Fig. 16
34	Fig. 17	Fig. 17
36	Fig. 18	Fig. 18
38	Fig. 19	Fig. 19
40	Fig. 20	Fig. 20
42	Fig. 21	Fig. 21
44	Fig. 22	Fig. 22
46	Fig. 23	Fig. 23
48	Fig. 24	Fig. 24
50	Fig. 25	Fig. 25
52	Fig. 26	Fig. 26
54	Fig. 27	Fig. 27
56	Fig. 28	Fig. 28
58	Fig. 29	Fig. 29
60	Fig. 30	Fig. 30
62	Fig. 31	Fig. 31
64	Fig. 32	Fig. 32
66	Fig. 33	Fig. 33
68	Fig. 34	Fig. 34
70	Fig. 35	Fig. 35
72	Fig. 36	Fig. 36
74	Fig. 37	Fig. 37
76	Fig. 38	Fig. 38
78	Fig. 39	Fig. 39
80	Fig. 40	Fig. 40
82	Fig. 41	Fig. 41
84	Fig. 42	Fig. 42
86	Fig. 43	Fig. 43
88	Fig. 44	Fig. 44
90	Fig. 45	Fig. 45
92	Fig. 46	Fig. 46
94	Fig. 47	Fig. 47
96	Fig. 48	Fig. 48
98	Fig. 49	Fig. 49
100	Fig. 50	Fig. 50

Manual Section	Example	A Z I M U T H	Page
88	H - 4	Polaris at elongation, observing program "b"	31
	H - 5	Ditto	32
90	H - 6	Polaris at elongation, observing program "c"	33
97	I - 1	Sunset hour angle observation of Polaris for azimuth; observing program "a"	34
	I - 2	Ditto	35
	I - 3	Ditto	36
98	I - 4	Sunset hour angle observation of Polaris for azimuth; observing program "b"	37
	I - 5	Ditto; a set of three complete observations	38
	I - 6	Ditto; one set of four observations	40
	I - 7	Ditto; same by repetition of angles	41
	I - 8	Ditto; one set of four observations, including reading of vertical angles and reduction for latitude	42

A Z I M U T H A N D T I M E

THE SUN, NORTH DECLINATION

108	J - 1	Reduction by the short formula, azimuth	43
109		Reduction by the alternate equation, azimuth	44
110		Reduction by the long equation, azimuth	44
111		Reduction by the long equation, time	45
108	J - 2	Reduction by the short formula, azimuth	46
109		Reduction by the alternate equation, azimuth	47
110		Reduction by the long equation, azimuth	48
111		Reduction by the long equation, time	48
108		Reduction by the short formula, time	49
108	J - 3	Reduction by the short formula, azimuth; a set of four observations, centered on the sun; see comment with the observation	50
108 100	J - 4	Reduction by the short formula, azimuth; observations a.m. and p.m. to compensate for eccentricity of vertical circle	52
109 100	J - 5	Reduction by the alternate equation, azimuth; observations a.m. and p.m. for verification	54
100	J - 6	Observations a.m. and p.m., azimuth; for test and analysis of eccentricity of vertical circle	59
100	J - 7	A set of three observations, azimuth; with application of corrections for eccentricity of vertical circle	62

Manual Section	Example	TWO EQUATORIAL STARS AND POLARIS	Page
100	K - 1	Observations southeasterly and southwesterly, for time and azimuth, balanced to compensate for eccentricity of vertical circle; sunset hour angle observation of Polaris, observing program "b" by repetition of angles, for verification of azimuth	64
		TIME ,	
		LATITUDE AND AZIMUTH	
	L - 1	The sun, Polaris, and one equatorial star	67
112 100	M - 1	An observation with the <u>solar circle</u> , a.m. and p.m.; azimuth only	70
112 100	M - 2	Ditto; shows compensation for eccentricity of vertical circle	72
113 100	N - 1	One complete stellar observing program; 1st star easterly, for time and azimuth	74
114		Ditto; 2nd star westerly, for time and azimuth	76
115		Ditto; Polaris, for latitude and azimuth	77
116		Ditto; 4th Star, meridian passage, for time and latitude	79
114	N - 2	Equatorial star, for time and azimuth	80
106	O - 1	Altitude observation of the sun for azimuth	82
114		Stellar altitude observation for azimuth	83
88		Polaris at elongation, observing program "b"	84
75		Meridian observation of the sun for time and latitude	84
75 76 98	O - 2	Polaris at sunrise and sunset; the sun at meridian passage; time, latitude, and azimuth	85
		TIME ,	
		LATITUDE AND AZIMUTH	
120	P - 1	Equal altitude observation of the sun	86
127		Ditto: by reduction to the sun's center	87
	P - 2	Equal altitude observation of the sun	88
		Ditto: by reduction to the sun's center	89
123	Q - 1	Stellar equal altitude observation	90
	Q - 2	Ditto	92

AZIMUTH AND TIME

THE SUN, SOUTH DECLINATION

Appendix II	R - 1	The complete data for the observation	94
108		Reduction by the short formula; ditto, for time	95
109		Reduction by the alternate equation, azimuth	96
110		Reduction by the long equation, azimuth	96
111		Reduction by the long equation, time	97
		Reduction by a third equation, time	97

Appendix II	R - 2	The complete data for the observation	98
108		Reduction by the short formula; ditto, for time	99
109		Reduction by the alternate equation, azimuth	100
110		Reduction by the long equation, azimuth	101
111		Reduction by the long equation, time	101

TEST OF THE SOLAR UNIT

81	S - 1	The sun p. m., time and azimuth; Polaris at sunset, latitude and azimuth; the sun at noon, time and latitude	102
----	-------	--	-----

Section	Page	Section	Page
100	100	100	100
101	101	101	101
102	102	102	102
103	103	103	103
104	104	104	104
105	105	105	105
106	106	106	106
107	107	107	107
108	108	108	108
109	109	109	109
110	110	110	110
111	111	111	111
112	112	112	112
113	113	113	113
114	114	114	114
115	115	115	115
116	116	116	116
117	117	117	117
118	118	118	118
119	119	119	119
120	120	120	120
121	121	121	121
122	122	122	122
123	123	123	123
124	124	124	124
125	125	125	125
126	126	126	126
127	127	127	127
128	128	128	128
129	129	129	129
130	130	130	130
131	131	131	131
132	132	132	132
133	133	133	133
134	134	134	134
135	135	135	135
136	136	136	136
137	137	137	137
138	138	138	138
139	139	139	139
140	140	140	140
141	141	141	141
142	142	142	142
143	143	143	143
144	144	144	144
145	145	145	145
146	146	146	146
147	147	147	147
148	148	148	148
149	149	149	149
150	150	150	150

Example of daylight altitude observation of a star for time and azimuth:

Place: Washington, D. C. Latitude: $38^{\circ} 53' 30''$ N. Longitude: $77^{\circ} 02' W.$
 Date: July 28, 1944. Observer: J. C. Thoma Instrument: Buff No. 23461
 Recorder: O. B. Walsh
 Time : A. D. Kidder

Sun's decl., Gr. app. noon $18^{\circ} 57' 28.4''$ N.
 Red. to long. $77^{\circ} 02' W.$ or $5^h 08^m$
 " " time of obsn. p.m. $4.30 = 9.63 \times 34.8'' (335'')$
 Refraction in polar distance $\frac{5.35}{1.02} \left(\frac{S.}{N.} \right)$
 The sun's app. decl. $18^{\circ} 52' 55''$ N.

At $4^h 30^m$ p.m., app. t., I set the arcs of the solar unit, lat. $38^{\circ} 53' 30''$ N., and decl. $18^{\circ} 53' N.$, and orient to the meridian, setting a reference mark South.

App. t. of sunset $7^h 05^m$ p.m. Gr.m.t. star's transit, July 19: $11^h 57.5^m$ p.m.
 Equ. of time (add) $\frac{6}{6}$ Red. to " 28: 35.4
 " " long. $77^{\circ} 02' W.$ " 0.8
 Sunset, l.m.t. $7^h 11^m$ p.m. Star's transit, l.m.t. " 28: $11^h 21.3^m$ p.m.
 Star: 25/49 0.9 Anticipated l.m.t. of obsn. " $\frac{6.40}{6.40}$
 " Aquila (Altair) Hour angle SE. ($70^{\circ} 15'$) $4^h 11^m$
 " $+6^{\circ} 43.4'$
 Latitude: $38^{\circ} 53' 30''$ N. Watch: O.K.: l.m.t.
 " slow of E.W.T.: $1^h 08^m$

$$\sin h = \cos t \cos \varphi \cos \delta + \sin \varphi \sin \delta \quad \cos A = \frac{\sin \delta}{\cos \varphi \cos h} - \tan \varphi \tan h$$

\cos	\sin	\cos	\sin	\tan
$t = .3379$		\cos	\sin	
$\varphi = .7783$	$.6278$	$.7783$		$.8067$
$\delta = .9884$	$.1516$		$.1516$	
$.2599$	$.0952$ (Products)			
	$.2592$			
$\sin h =$	$.3551$ (Sum)			
$h = 20^{\circ} 48'$		$.9348$		$.3799$
		$.7276$		$.3065$ (Products)
		$.2064$		$.2084$ (Fraction)
		$\cos A =$		$.0981$ (Diff. -)
		$A = 86^{\circ} 22' E.$		

See page 2 for observation.

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

... of the ...
... of the ...
... of the ...

With the above settings, at 6^h40^m p.m., l.m.t., I find the star in good position and proceed with 6 observations, the 1st as follows:

Watch time of obsn.: 6^h45^m20^s p.m.
 Horizontal angle from star to reference mark: 83°36'00"
 Observed vertical angle: $\varphi = 21'44''$
 Refraction: $r = -2'24''$
 True vertical angle: $h = 21'41'36''$

$$\cos t = \frac{\sin h}{\cos \varphi \cos \delta} - \tan \varphi \tan \delta \quad \cos A = \frac{\sin \delta}{\cos \varphi \cos h} - \tan \varphi \tan h$$

	cos	sin	tan		cos	sin	tan
$h =$	.77833	.36964	.80666		.92918	.39781	
$\varphi =$	.98844		.15342		.77833	.80666	
$\delta =$	.76933		.12376	(Products)		.15166	
		.48050	(Fraction)		.72321	.32090	(Products)
		.12376				.20970	(Fraction)
$\cos t =$		.35674	(Diff. +)	$\cos A =$		.11120	(Diff. -)

$t = 69'06''$
 $A = 83'37'00''E.$
 $83'36'00''$ Obsvd. hor. ang.
 $S. 0'01'00''E.$ Reference mark.
 $4^h36^m24^s$ Sidereal h.a.
 $- 44$ Red. to m.t.h.a.
 $4^h35^m40^s$ Mean time h.a.
 $11\ 21\ 18$ Star's transit, p.m., l.m.t.
 $6^h45^m38^s$ Correct l.m.t. of obsn.
 $6\ 45\ 20$ Watch time of obsn.
 0^m18^s Watch slow of l.m.t.

(1) Reduced bearing of reference mark
 " watch slow of l.m.t.

Watch
slow,
l.m.t.
18^s
Bearing
reference
mark
S. 0°01'00"E.

	Time	Observed Vert. Ang.	Observed Hor. Ang.		
2	6 ^h 41 ^m 00 ^s	22°50'30"	82°40'00"	24	S. 0°00'30"W.
3	6 57 30	24°05'00"	81°34'00"	20	South
4	7 00 00	24°35'00"	81°08'00"	25	S. 0°00'30"W.
5	7 04 54	25°31'00"	80°18'00"	22	S. 0°00'30"W.
6	7 08 12	26°09'00"	79°43'00"	23	South
			Mean	22 ^s	S. 0°00'05"W.

THESE DOCUMENTS SONT DES REPRODUCTIONS DE DOCUMENTS
 D'ARCHIVES DE LA GENDARMERIE NATIONALE

LES DOCUMENTS SONT CLASSIFIES EN VUE DE LA
 PROTECTION DES DROITS FONDAMENTAUX
 ET EN VUE DE LA PROTECTION DES
 DROITS DE LA DEFENSE

LES DOCUMENTS SONT CLASSIFIES EN VUE DE LA
 PROTECTION DES DROITS FONDAMENTAUX
 ET EN VUE DE LA PROTECTION DES
 DROITS DE LA DEFENSE

DATE	OBJET	REMARQUES
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100

LES DOCUMENTS SONT CLASSIFIES EN VUE DE LA
 PROTECTION DES DROITS FONDAMENTAUX
 ET EN VUE DE LA PROTECTION DES
 DROITS DE LA DEFENSE

LES DOCUMENTS SONT CLASSIFIES EN VUE DE LA
 PROTECTION DES DROITS FONDAMENTAUX
 ET EN VUE DE LA PROTECTION DES
 DROITS DE LA DEFENSE

C Pegasi.

Date: Oct. 31, 1944:

Instrument: Gurley No. 371653

Observer: Lloyd E. Toland
Recorder and time: Jesse L. Gassman.

Sun's decl., Gr. app. noon $14^{\circ} 09' 30.7''$ S.
 Red. to long. $104^{\circ} 28' 00''$ W. or $6^{\text{h}} 58^{\text{m}}$
 " " time of obsn. p.m. $4^{\text{h}} 02^{\text{m}} 11^{\text{s}}$ x $48.55''$ ($53.4''$) $8^{\text{h}} 54^{\text{m}}$ (S)
 Refraction in polar distance $2^{\text{h}} 14^{\text{m}}$ (N)
 The sun's app. decl. $14^{\circ} 16' 11''$ S.

At $4^{\text{h}} 02^{\text{m}}$ p.m., app. t., I set off the arcs of the solar unit, lat. $32^{\circ} 50' 30''$ N., and decl. $14^{\circ} 16' 11''$ S., and orient to the meridian, setting a reference mark South.

App. t. of sunset $5^{\text{h}} 22^{\text{m}}$ p.m. Gr.m.t. star's transit, Oct. 16: $9^{\text{h}} 21.0^{\text{m}}$ p.m.
 Equat. of time (sub) 16 Red. to " $31^{\text{m}} 59$
 Sunset, l.m.t. $5^{\text{h}} 06^{\text{m}}$ p.m. " " long. $104^{\circ} 28' 00''$ W. " 1.1
 Star's transit, l.m.t. " $31^{\text{h}} 8^{\text{m}} 20.9^{\text{s}}$ p.m.
 Anticipated l.m.t. of obsn. $5^{\text{h}} 21$
 Hour angle SE. (45°) $3^{\text{h}} 00^{\text{m}}$

Latitude: $32^{\circ} 50' 23.21''$ N. Watch: O.K.; M.W.T. by radio.
 " : fast l.m.t. $57^{\text{m}} 52^{\text{s}}$

$$\sin h = \cos t \cos \phi \cos d + \sin \phi \sin d \cos A = \frac{\sin d}{\cos \phi \cos h} - \tan \phi \tan h$$

\cos	\sin	\cos	\sin	\tan
$t = .70711$				
$\phi = .84019$	$.54229$	$.84019$		$.64544$
$d = .96633$	$.25730$		$.25730$	
	$.57410$			
	$.13953$			
	$.57410$			
$\sin h =$	$.71363$			
$h = 45^{\circ} 32'$		$.70049$		1.01879
		$.58854$		$.65757$
			$.43718$	$.43718$
				$.22039$
				$\cos A =$
				$A = S. 77^{\circ} 16' E.$

With the above settings, at $5^{\text{h}} 13^{\text{m}}$ p.m., l.m.t., I find the star in good position and proceed with 6 direct and 6 reversed readings; recording the mean of the 1st. direct and 6th reversed, 2nd direct and 5th reversed, etc. The first mean as follows:

Watch time of obsn.: $6^{\text{h}} 13^{\text{m}} 34^{\text{s}}$ p.m.
 Horizontal angle from star to reference mark: $78^{\circ} 17' 30''$
 Observed vertical angle: $v = 44^{\circ} 22' 30''$
 Refraction: $r = 1' 00''$
 True vertical angle: $h = 44^{\circ} 21' 30''$

$$\cos t = \frac{\sin h}{\cos \phi \cos d} \quad \cos A = \frac{\sin d}{\cos \phi \cos h} - \tan \phi \tan h$$

\cos	\sin	\tan	\cos	\sin
$h = .84020$	$.69915$		$.71198$	$.97784$
$\phi = .84020$		$.64544$	$.84020$	$.64544$
$d = .96634$		$.26623$		$.25727$
	$.81192$		$.60073$	
	$.86111$	$.17184$		$.42826$
	$.17184$			$.63114$
	$.68927$			$.42826$
$\cos t =$			$\cos A =$	$.20288$
$t = 46^{\circ} 25' 40''$			$A = S. 78^{\circ} 17' 42'' E.$	
$3^{\text{h}} 5^{\text{m}} 43^{\text{s}}$ Sideral h.a.			$78^{\circ} 17' 30''$ Obsd. h. a.	
$1^{\text{h}} 9^{\text{m}}$ Red. to m.t.h.a.			$S. 0^{\circ} 00' 12'' E.$ Ref. m.kd.	
$3^{\text{h}} 1^{\text{m}} 34^{\text{s}}$ Mean time h.a.				
$8^{\text{h}} 20^{\text{m}} 54^{\text{s}}$ Star's transit, p.m., l.m.t.				
$5^{\text{h}} 16^{\text{m}} 20^{\text{s}}$ Correct l.m.t. of obsn.				
$6^{\text{h}} 13^{\text{m}} 34^{\text{s}}$ Watch time of obsn.				
$57^{\text{m}} 14^{\text{s}}$ Watch fast of l.m.t.				

1. The first step in the process of the scientific method is to make an observation or ask a question.

2. Next, a hypothesis is made, which is an educated guess or prediction about the outcome of the experiment.

3. The hypothesis is then tested by conducting an experiment. This involves collecting data and analyzing the results.

4. After the experiment is completed, the results are compared to the hypothesis. If the results support the hypothesis, it is accepted. If not, it is rejected.

5. The final step is to draw a conclusion based on the results of the experiment. This conclusion may lead to further questions and experiments.

6. The scientific method is a systematic approach to investigating a question or problem. It is used by scientists in all fields of study.

7. The scientific method is a process that allows scientists to test their ideas and make discoveries. It is a key part of the scientific revolution.

8. The scientific method is a process that involves making observations, asking questions, making hypotheses, testing hypotheses, and drawing conclusions.

9. The scientific method is a process that is used by scientists to investigate the natural world. It is a key part of the scientific revolution.

				Watch fast, l.m.s.	Bearing reference mark
(1) Reduced bearing of reference mark " watch fast of l.m.s.				57m11s	8.0°00'12"E.
Time		Observed			
		Vert. Ang.	Hor. Ang.		
2	6h13m28s	44°21'30"	78°18'00"	57 13	8.0°00'30"E.
3	6 13 25	44°21'00"	78°18'30"	57 03	8.0°00'20"E.
4	6 13 20	44°20'30"	78°18'30"	57 09	8.0°00'41"E.
5	6 13 18	44°19'30"	78°19'30"	57 12	8.0°00'23"E.
6	6 13 12	44°20'00"	78°19'00"	57 05	8.0°00'32"E.
Mean				57m09s	8.0°00'26"E.

1. The first part of the report is a general introduction to the project. It describes the purpose of the study and the objectives that were set at the beginning.

2. The second part of the report is a detailed description of the methodology used in the study. It includes information about the data sources, the sample size, and the statistical methods that were used to analyze the data.

3. The third part of the report is a presentation of the results of the study. It includes a summary of the findings and a discussion of the implications of the results.

4. The fourth part of the report is a conclusion. It summarizes the main findings of the study and provides recommendations for future research.

B. Orionis.

Date: Nov. 1, 1944.

Observer: Lloyd E. Toland
Recorder and time: Jesse L. GassmanInstrument:
Gurley No.
371653Reference mark set South as used in observation on a Pegasi, Oct. 31, 1944.

App. t. of sunrise 6h39m a.m. Gr.m.t. star's transit, Nov. 1: 2h30.8m a.m.
 Equa. of time (sub) 16 Red. to long. 104° 28' W. = 1.1
 Sunrise, l.m.t. 6h23m a.m. Star's transit, l.m.t. " 1: 2h29.7m a.m.
 Star: 7/11 0.3 Anticipated l.m.t. of obsn. : 6 02 a.m.
 β Orionis (Rigel) Hour angle SW. (53°) 3h32m
 = 8°15.8' Watch: fast 1.m.t.: 30s
 " " M.W.T.: 58m22s

Latitude: 32°50'23"N.

$$\sin h = \cos t \cos \phi \cos d + \sin \phi \sin d; \cos A = \frac{\sin d}{\cos \phi \cos h} = \frac{\tan \phi \tan h}{\sin d} \quad (*)$$

$t =$	$\frac{\cos}{.60182}$	$\frac{\sin}{.54228}$	$\frac{\cos}{.84020}$	$\frac{\sin}{.14372}$	$\frac{\tan}{.64544}$
$\phi =$	$.84020$	$.54228$	$.84020$	$.14372$	$.64544$
$d =$	$.98962$	$.14372$			
	$.50040$	$.07794$			
	$.07794$				
$\sin h =$	$.12216$				
$h =$	$21^{\circ}59'$		$.90643$		$.46595$
			$.76158$		$.30074$
				$.18871$	$.18871$
			$\cos A =$		$.48945$
			$A =$	$8.60^{\circ}42'W.$	

With the above settings, at 6h02m a.m., l.m.t., I find the star in good position and proceed with 6 direct and 6 reversed readings, with the reversal made at the end of the 6th direct reading, recording the mean of the first direct and 6th reverse, the 2nd direct and 5th reverse readings, etc. The list as follows:

Watch time of observations: 7h05m16s a.m.
 Horizontal angle from star to reference mark: 61°50'
 Observed vertical angle: $v = 23^{\circ}52'$
 Refraction: $r = 2'10''$
 True vertical angle: $h = 23^{\circ}49'50''$

$$\cos t = \frac{\sin h}{\cos \phi \cos d} = \tan \phi \tan d \quad (*)$$

$h =$	$\frac{\cos}{.84020}$	$\frac{\sin}{.10104}$	$\frac{\tan}{.64544}$	$\frac{\cos}{.91476}$	$\frac{\sin}{.14169}$	$\frac{\tan}{.64544}$
$\phi =$	$.84020$	$.10104$	$.64544$	$.91476$	$.14169$	$.64544$
$d =$	$.98962$	$.14520$	$.09372$	$.84020$	$.14372$	$.64544$
	$.83148$	$.09372$	$.09372$	$.76856$	$.18700$	$.18700$
		$.48993$	$.09372$		$.26508$	$.26508$
		$.57965$			$.18700$	$.18700$
$\cos t =$						$.47208$
$t =$	$54^{\circ}41'30''$			$\cos A =$		
	$3h38m18s$	Sidereal h.a.		$A = 8.61^{\circ}49'50''W.$		
	$1 09$	Red. to m.t.h.a.		$61^{\circ}50'00''$	Obsvd. h. a.	
	$3h37m09s$	Mean time h.a.		$8.0^{\circ}00'10''S.$	Ref. mark.	
	$2 29 42$	Star's transit, a.m., l.m.t.				
	$6h05m51s$	Correct l.m.t. of obsn.				
	$7 05 16$					
	$58m25s$	Watch fast of l.m.t.				

(1) Reduced bearing of reference mark				Watch fast, l.m.t.	Bearing reference mark
" watch fast of l.m.t.				58m25s	S.0°00'10"E.
Time.	Observed Vert. Ang.	observed Hor. Ang.			
2 7h05m17s	23°51'	61°50'30"		58 21	South
3 7 05 20	23°51'	61°51'00"		58 27	S.0°00'30"E.
4 7 05 25	23°50'	61°51'30"		58 24	S.0°00'14"E.
5 7 05 20	23°52'	61°50'30"		58 29	S.0°00'46"E.
6 7 05 22	23°50'	61°52'00"		58 21	S.0°00'14"E.
		Mean		58m24s	S.0°00'24"E.

10/10/00
10/10/00
10/10/00
10/10/00

10/10/00
10/10/00
10/10/00
10/10/00

10/10/00 10/10/00 10/10/00

10/10/00
10/10/00
10/10/00
10/10/00
10/10/00
10/10/00

10/10/00
10/10/00
10/10/00
10/10/00
10/10/00
10/10/00

10/10/00 10/10/00 10/10/00
10/10/00 10/10/00 10/10/00
10/10/00 10/10/00 10/10/00
10/10/00 10/10/00 10/10/00
10/10/00 10/10/00 10/10/00
10/10/00 10/10/00 10/10/00

ALTITUDE OBSERVATION OF A STAR FOR AZIMUTH.

Date
October 23, 1944Observer: Norman D. Price
Recorder: George F. RigbyInstrument
Buff No. 17998

In order to determine a meridian at my station in the SW $\frac{1}{2}$ of NW $\frac{1}{2}$ of sec. 25, T. 1 N., R. 1 E., Willamette Mer., Oregon, in lat. $45^{\circ}32'30''$ N., and long. $122^{\circ}39'W.$, I proceed with the preliminary preparation, and with a series of six altitude observations, three each with the telescope in direct and reversed positions, upon the star (Alpha) Ophiuchi as follows:

Sun's decl. Greenwich app. noon ----- $12^{\circ}09'08.1''$ S.
 Red. to long. $122^{\circ}39'W.$ $3h10m36s$
 Red. to time of obsn. p.m. $\pm 01 24 = 12.2 \times 51.66'' = (630.3'')$ 10 30.3 (S.)
 Refraction in polar distance $\frac{3}{2} 50 (N.)$
 The sun's apparent declination $12^{\circ}15'48''$ S.

At 4h01.4m p.m., app.t., I set the arcs of the solar unit, lat. $45^{\circ}32\frac{1}{2}''$ N., and decl. $12^{\circ}16'S.$, and orient to the meridian, setting a reference mark South.

App.t. of sunset 5h09m p.m. Gr. m.t. star's transit Oct. 16: 5h52.2m p.m.
 Equ. of t. = $\frac{16m}{453m}$ Red. to Oct. 23: -55.4
 Sunset, l.m.t. = 4h53m p.m. Red. to long. $122^{\circ}39'W.$ - $1\frac{1}{2}$
 Stars: 22/44 2.1 Star's transit, l.m.t. Oct. 23: 5h15.5m p.m.
 (Alpha) Ophiuchi Anticipated l.m.t. of obsn. Oct. 23: 5h55.0m p.m.
 Hour angle SW. ($39^{\circ}52.5'$) 2h39.5m
 Latitude $45^{\circ}32'30''$ N. Watch: correct: l.m.t.
 Watch: slow of P.W.T.: 1h 10m 36s

$$\sin h = \cos t \cos \phi \cos d + \sin \phi \sin d \quad \cos A = \frac{\sin d}{\cos \phi \cos h} - \tan \phi \tan h$$

$t = \frac{\cos}{.76744}$	$\frac{\sin}{.71576}$	$\frac{\cos}{.70039}$	$\frac{\sin}{.21820}$	$\frac{\tan}{1.01909}$
$\phi = .70039$	$.71576$	$.70039$	$.21820$	
$d = \frac{.97591}{.52456}$	$\frac{.21820}{.15574}$ (Products)			
	$\frac{.52456}{.68050}$ (Sum)			
$\sin h =$	$.68050$	$\frac{.73294}{.51354}$		$\frac{.92817}{.94569}$ (Products)
$h = 42^{\circ}52'$		$.42506$		$\frac{.42506}{.52065}$ (Fraction)
		$\cos A =$		$\frac{.52065}{.52065}$ (Diff. -)
		$A =$		$S. 58^{\circ}57' W.$

With the above settings, at 5h55m p.m., l.m.t., I find the star in good position and proceed with six observations, the first as follows:

Watch time of obsn. 5h 57m 02s p.m.
 Horizontal angle from star to reference mark ----- $59^{\circ}15'30''$
 Observed vertical angle: $v = 42^{\circ}31'$ Latitude: $\phi = 45^{\circ}32'30''$ N.
 Refraction: $r = -1'03''$ Declination: $d = 12^{\circ}56'12''$ N.
 True vertical angle: $h = 42^{\circ}29'57''$

$$\cos A = \frac{\sin d}{\cos \phi \cos h} - \tan \phi \tan h$$

$\log \sin d = 9.358855$	$\log \tan \phi = 10.008212$
$\log \cos \phi = 9.845351$	$\log \tan h = 9.962072$
Difference = 9.495514	Sum = 9.970251
$\log \cos h = 9.865637$	2nd term = $.93379$ Natural (-)
Difference = 9.625877	1st term = $.42255$ Natural (+)
1st term = $.42255$ Natural (-)	$\cos A = .51124$ Diff. (-)
	$A = 59^{\circ}15'12''$
Observed horizontal angle	$= 59^{\circ}15'30''$
Bearing of reference mark	$= S. 0^{\circ}00'18'' E.$

	Time	Observed Vert. Ang.	Observed Hor. Ang.	Bearing of Reference mark
(1)	5h 57m 02s	$42^{\circ}51'00''$	$59^{\circ}15'30''$	$S. 0^{\circ}00'18'' E.$
(2)	5h 58m 20s	$42^{\circ}18'00''$	$59^{\circ}38'00''$	$S. 0^{\circ}00'26'' E.$
(3)	5h 59m 29s	$42^{\circ}07'30''$	$59^{\circ}56'00''$	$S. 0^{\circ}00'26'' E.$
(4)	6h 02m 48s	$41^{\circ}38'00''$	$60^{\circ}46'00''$	$S. 0^{\circ}00'48'' E.$
(5)	6h 04m 13s	$41^{\circ}25'00''$	$61^{\circ}07'00''$	$S. 0^{\circ}00'12'' E.$
(6)	6h 05m 39s	$41^{\circ}12'30''$	$61^{\circ}28'00''$	$S. 0^{\circ}00'39'' E.$
			Mean -----	$S. 0^{\circ}00'25'' E.$

Altitude Observation of the Sun for Apparent Time.

Date September 4, 1944 Observer Norman D. Price Instrument Buff No. 17998

At camp, in sec. 5, T. 25 S., R. 3 W., Willamette Meridian, Oregon, in. lat. $43^{\circ} 25' 30''$ N., and long. $123^{\circ} 04' 25''$ W., to check the reading of my watch which indicates approximate standard time for the 120th meridian, I make an altitude observation of the sun for time, making two observations, one each with the telescope in reversed and direct positions, observing opposite limbs of the sun, as follows:

Mean observed vertical angle----- $28^{\circ} 18' 30''$
 Mean watch time of observation-----3h 59m 27s p.m.
 Watch fast of l.m.t. (theoretical)-----12m 18s
 Mean temperature at time of obsn----- 96° Fahr.
 Elevation above sea level of station-----950 ft.

Telescope	Sun's limb's	Watch time.	Vertical Angle.
Reversed-----	a	3h 58m 00s p.m.	$28^{\circ} 19' 00''$
Direct-----	b	4h 00m 54s	$28^{\circ} 18' 00''$
Mean-----		3h 59m 27s p.m.	$28^{\circ} 18' 30'' = v$
Refraction (corrected for temperature and elevation above sea level), $107'' \times .92 \times .98 =$ minus $1' 36.47''$			
Sun's parallax----- = plus $7.72''$			
h = $28^{\circ} 17' 01''$			

True vertical angle $= h = 28^{\circ} 17' 01''$
 Zenith distance $= Z = 61^{\circ} 42' 59''$
 Sun's declination $= D = 6^{\circ} 57' 02''$ N.
 Latitude $= \phi = 43^{\circ} 25' 30''$ N.

T-hour angle from apparent noon in angular measure.

$$\tan \frac{1}{2} T = \sqrt{\frac{\sin \frac{1}{2} (Z + \phi - D) \sin \frac{1}{2} (Z - \phi + D)}{\cos \frac{1}{2} (Z + \phi + D) \cos \frac{1}{2} (Z - \phi - D)}}$$

$$\begin{array}{ll} Z = 61^{\circ} 42' 59'' & Z = 61^{\circ} 42' 59'' \\ \phi = 43^{\circ} 25' 30'' & \phi = 43^{\circ} 25' 30'' \\ Z + \phi = 105^{\circ} 08' 29'' & Z - \phi = 18^{\circ} 17' 29'' \\ D = 6^{\circ} 57' 02'' (+) & D = 6^{\circ} 57' 02'' (+) \\ Z + \phi + D = 112^{\circ} 05' 31'' & Z - \phi + D = 25^{\circ} 14' 31'' \\ Z + \phi - D = 105^{\circ} 08' 29'' & Z - \phi - D = 18^{\circ} 17' 29'' \\ D = 6^{\circ} 57' 02'' (+) & D = 6^{\circ} 57' 02'' (+) \\ Z + \phi - D = 98^{\circ} 11' 27'' & Z - \phi - D = 11^{\circ} 20' 27'' \\ \log \sin \frac{1}{2} (Z + \phi - D) = & 9.878407 \\ \sin \frac{1}{2} (Z - \phi + D) = & 9.339448 \\ \cos \frac{1}{2} (Z + \phi + D) = 9.747047 & 9.217855 \\ \cos \frac{1}{2} (Z - \phi - D) = 9.997869 & \\ & 9.744916 \\ \tan \frac{1}{2} T = & 9.472939 \\ \tan \frac{1}{2} T = & 9.735469 \\ & 9.744916 \end{array}$$

$\frac{1}{2} T = 28^{\circ} 35' 40''$ $T = 57^{\circ} 11' 20''$
 Apparent time of observation-----3h 48m 45s p.m.
 Equation of time-----minus $1' 12''$
 Local mean time of observation-----3h 47m 33s p.m.
 Difference in time for long.-----add $12' 18''$
 120th mer. time of observation-----3h 59m 51s p.m.
 Watch time of observation-----3h 59m 27s p.m.
 Watch slow of 120th mer. time-----24s

Altitude Observation of a Star for Time.

Star 22/44 (Alpha) Ophiuchi, Mag. 2.1
+12° 36.2'

Date Observer: Norman D. Price Instrument
October 25, 1944 Recorder: George F. Rigby Buff No. 17998

At my station, in SW $\frac{1}{2}$ of NW $\frac{1}{2}$ of sec. 25, T. 1 N., R. 1 E. Willamette Meridian, Oregon, in latitude 45° 32' 30" N., and longitude 122° 39' W., to check the reading of my watch which indicates approximate Pacific war time, I make a series of six altitude observations, three each with the telescope in direct and reversed positions, upon the star (Alpha) Ophiuchi, as follows:

Telescope.	Watch time.	Vertical angle.
Direct-----	7h 08m 07s p.m.	42° 31' 00"
Direct-----	7h 09m 25s	42° 18' 00"
Direct-----	7h 10m 34s	42° 07' 30"
Reversed-----	7h 13m 53s	41° 38' 00"
Reversed-----	7h 15m 18s	41° 25' 00"
Reversed-----	7h 16m 44s	41° 12' 30"

Mean temperature at time of obsn.-----50° Fahr.
Barometric reading at time of obsn.-----29.6 ins.

Transit of (Alpha) Ophiuchi, civil date and mean time, is

3h 52m 12s p.m., October 16, 1944
Sub. 35m 24s correction to October 25
3h 16m 48s p.m., transit Greenwich Meridian
Sub. 1m 20s reduction for longitude of this station
3h 15m 28s p.m., l.m.t. transit of (Alpha) Ophiuchi.
1h 10m 36s-additive for correction to Pacific war time.

$$\cos t = \frac{\sin h}{\cos \phi \cos d} - \tan \phi \tan d$$
 Formula for derivation of
sidereal hour angle "t"
in angular measure.

t = sidereal hour angle expressed in angular measure.
h = vertical angle corrected for refraction, (r)
 ϕ = latitude of station = 45° 32' 30" N.
d = declination of star = 12° 36' 12" N.

The following reductions are made to obtain the true vertical angles of the above observations:

	1st obsn.	2nd obsn.	3rd obsn.	4th obsn.	5th obsn.	6th obsn.
r =	42° 31' 00"	42° 18' 00"	42° 07' 30"	41° 38' 00"	41° 25' 00"	41° 12' 30"
ϕ =	-1 03	-1 03	-1 04	-1 05	-1 05	-1 06
h =	42° 29' 57"	42° 16' 57"	42° 06' 26"	41° 36' 55"	41° 23' 55"	41° 11' 24"

Solutions of observations by foregoing formula are as follows:

Two operations are common to reduction of all six observations.

Denominator of 1st term

log cos ϕ = 9.845341

log cos d = 9.985407

Sum = 9.834748 = log SD

Anti-log of 2nd term

log tan ϕ = 10.008212

log tan d = 9.349448

Sum = 9.357660

Anti-log = .22786 = W2

1. The first part of the report is a general introduction to the subject of the study. It discusses the importance of the study and the objectives of the research. It also provides a brief overview of the methodology used in the study.

2. The second part of the report is a detailed description of the study area. It includes information about the location of the study area, the population of the study area, and the characteristics of the study area. It also discusses the data sources used in the study.

3. The third part of the report is a description of the methodology used in the study. It includes information about the research design, the data collection methods, and the data analysis methods. It also discusses the limitations of the study.

4. The fourth part of the report is a description of the results of the study. It includes information about the findings of the study and the conclusions drawn from the study. It also discusses the implications of the study.

5. The fifth part of the report is a conclusion and a list of references. It includes a summary of the findings of the study and a list of the references used in the study.

Name	Age	Sex
John Doe	25	Male
Jane Smith	30	Female
Bob Johnson	20	Male
Alice Brown	28	Female
Charlie White	22	Male

6. The sixth part of the report is a discussion of the results of the study. It includes information about the findings of the study and the conclusions drawn from the study. It also discusses the implications of the study.

7. The seventh part of the report is a conclusion and a list of references. It includes a summary of the findings of the study and a list of the references used in the study.

8. The eighth part of the report is a list of references. It includes a list of the references used in the study.

9. The ninth part of the report is a list of references. It includes a list of the references used in the study.

10. The tenth part of the report is a list of references. It includes a list of the references used in the study.

11. The eleventh part of the report is a list of references. It includes a list of the references used in the study.

12. The twelfth part of the report is a list of references. It includes a list of the references used in the study.

13. The thirteenth part of the report is a list of references. It includes a list of the references used in the study.

14. The fourteenth part of the report is a list of references. It includes a list of the references used in the study.

15. The fifteenth part of the report is a list of references. It includes a list of the references used in the study.

16. The sixteenth part of the report is a list of references. It includes a list of the references used in the study.

17. The seventeenth part of the report is a list of references. It includes a list of the references used in the study.

18. The eighteenth part of the report is a list of references. It includes a list of the references used in the study.

19. The nineteenth part of the report is a list of references. It includes a list of the references used in the study.

20. The twentieth part of the report is a list of references. It includes a list of the references used in the study.

Altitude Observation of a Star for Time.

1st obsn.	2nd obsn.	3rd obsn.
log sin h = 9.829676	log sin h = 9.827877	log sin h = 9.826412
log SD = 9.834748	subtract 9.834748	9.834748
9.994928	9.993129	9.991664
anti-log = .58839 1st term	.58430	.58099
N2 = .22786	subtract .22786	.22786
cos t = .76053	.75644	.75313
t = 40°29'20"	40°50'54"	41°08'16"
= 2h41m57s	2h43m24s	2h44m33s
-26s sidereal conversion	-27s	-27s
2h41m31s mean time hour angle	2h42m57s	2h44m06s
add 3h15m28s l.m.t.star's transit	3h15m28s	3h15m28s
5h56m59s l.m.t. of obsn.	5h58m25s	5h59m34s
add 1h10m36s corr. to P.W.T.	1h10m36s	1h10m36s
7h07m35s P.W.T. of obsn.	7h09m01s	7h10m10s
7h08m07s watch t. of obsn.	7h09m25s	7h10m34s
32s watch fast of P.W.T.	24s	24s
4th obsn.	5th obsn.	6th obsn.
log sin h = 9.822250	log sin h = 9.820394	log sin h = 9.81894
log SD = 9.834748	subtract 9.834748	9.834748
9.987502	9.985646	9.983846
anti-log = .97163 1st term	.96749	.96349
N2 = .22786	subtract .22786	.22786
cos t = .74377	.73963	.73563
t = 41°56'47"	42°18'00"	42°38'22"
= 2h47m47s	2h49m12s	2h50m33s
-28s sidereal conversion	-28s	-28s
2h47m19s mean time hour angle	2h48m44s	2h50m05s
add 3h15m28s l.m.t.star's transit	3h15m28s	3h15m28s
6h02m47s l.m.t. of obsn.	6h04m12s	6h05m33s
add 1h10m36s corr. to P.W.T.	1h10m36s	1h10m36s
7h13m23s P.W.T. of obsn.	7h14m48s	7h16m09s
7h13m53s watch t. of obsn.	7h15m18s	7h16m44s
30s watch fast of P.W.T.	30s	35s
By 1st obsn. watch fast of P.W.T.	32s	
By 2nd obsn. watch fast of P.W.T.	24s	
By 3rd obsn. watch fast of P.W.T.	24s	
By 4th obsn. watch fast of P.W.T.	30s	
By 5th obsn. watch fast of P.W.T.	30s	
By 6th obsn. watch fast of P.W.T.	35s	
Mean watch fast of P.W.T.	29s	

Meridian Observation of the Sun for Apparent Noon.

Observer: Geo. F. Rigby

Recorder: LeRoy V. Wollney

Date: September 9, 1944. Instrument: W. & L. E. Gurley No. 2350

September 9, 1944, in latitude $42^{\circ} 32' 24''$ N., and longitude $119^{\circ} 46' 30''$ W., with the telescope in the meridian and elevated to the sun's altitude, I observe the sun's transit for time, noting the watch time of transit of each limb:

Mean watch time of apparent noon = $12^h 55^m 52^s$ Watch fast of local mean time = $58^m 42^s$

Field Record.

Setting: $90^{\circ} 00' 00''$
 $\phi \neq (-) 42^{\circ} 32' 24''$ N.
 $d \neq (+) 5^{\circ} 08' 28''$ N.
 $v \neq 52^{\circ} 36' 04''$

\rightarrow Watch time of transit of W. limb = $12^h 54^m 48^s$

\rightarrow Watch time of transit of E. limb = $12 \quad 56 \quad 56$

Watch time of apparent noon = $12^h 55^m 52^s$

Apparent noon = $12^h 00^m 00^s$

Equa. of time = $- 2 \quad 50$

Local mean time of apparent noon = $11 \quad 57 \quad 10$

Watch fast of local mean time = $58^h 42^m$

Washington, D.C. 20540

Dear Mr. [Name]

Reference is made to your letter of [Date]

and in reply to inform you that the same has been forwarded to the appropriate authorities for their consideration.

Very truly yours,
[Signature]
[Title]
[Organization]

Enclosure

cc: [List of recipients]
[Initials]

Very truly yours,
[Signature]
[Title]
[Organization]

C - 2

MERIDIAN OBSERVATION OF THE SUN FOR APPARENT NOON.

Date.
Sept. 6, 1944.Observer.
Otis O. Gould.Instrument.
Buff and Buff No. 17998. $V = 90^\circ - \phi \pm D$

Final field notes.

Sept. 6, 1944, in camp located in sec. 5, T. 25 S., R. 3 W., Will. Mer., Oregon, in latitude $43^\circ 25' 30''$ N., and longitude $123^\circ 04\frac{1}{2}'$ W., with my watch set for pacific standard time as checked by radio time signals, with the telescope in the meridian and elevated to the sun's altitude, I observe the sun's transit for time, noting the watch time of transit of each limb:

Mean watch time of apparent noon 12h 10m 30s
 Watch fast of local mean time 12m 19s

Field record.

Setting:
 $\phi \approx \{ - \} \quad 90^\circ 00'$
 $D \approx \{ + \} \quad 43^\circ 25\frac{1}{2}' \text{ N.}$
 $\quad \quad \quad \quad \quad \quad \quad 5^\circ 16' \text{ N.}$
 $V \approx \quad \quad \quad \quad \quad \quad \quad \underline{52^\circ 50\frac{1}{2}'}$

~~W~~ Watch time of transit, W. limb = 12h 09m 26s
~~E~~ Watch time of transit, E. limb = 12h 11m 34s
 Watch time of apparent noon = 12h 10m 30s
 Apparent noon 12h 00m 00s
 Equation of time 1m 49s
 Local mean time of apparent noon = 11h 58m 11s
 Watch fast of local mean time = 12m 19s

MEMORANDUM FOR THE RECORD
SUBJECT: [illegible]
DATE: [illegible]
BY: [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

Meridian Observation of a Star for Time.

Star: 25/49 0.9 Declination
(Alpha) Aquilae (Altair) 8° 43' 24" N.

Date: Observer: Norman D. Price Instrument
October 26, 1944 Recorder: George F. Rigby Buff No. 17998

On a meridian previously determined at my station, in the SW $\frac{1}{4}$ of NW $\frac{1}{4}$ of sec. 25, T. 1 N., R. 1 E., of Willamette Meridian, Oregon, in latitude 45° 32' 30" N., and longitude 122° 39' W., with the telescope in the meridian and elevated to the star's altitude, to check the reading of my watch which indicates approximate Pacific war time, I observe the star's transit for time as follows:

Watch time of star's transit-----6h 37m 55s p.m.

Theoretical time for transit of star for this date is derived as follows:

6h 07m 36s p.m., Oct. 16 transit of star, Greenwich Meridian,
civil date and mean time.

39m 18s subtract, correction to Oct. 26.

5h 28m 18s p.m., Oct. 26 transit of star, Greenwich Meridian,
civil date and mean time.

1m 20s subtract, correction for longitude of this station.

5h 26m 58s p.m., l.m.t. Oct. 26 transit of star.

1h 10m 36s add, correction to Pacific war time.

6h 37m 34s p.m., P.W.T. Oct. 26 transit of star.

Watch time of star's transit-----6h 37m 55s p.m.

Theoretical time of star's transit-----6h 37m 34s p.m.

Watch fast of Pacific war time-----21s.

C - 4

Stellar Meridian Transit Observation for Time.

Observer: Geo. F. Rigby

Recorder: Norman D. Pries

Date: October 25, 1944. Instrument: W. & L. E. Gurley No. 2350

October 25, 1944, in latitude $45^{\circ} 32' 30''$ N., and longitude $122^{\circ} 39' 00''$ W., with the telescope in the meridian and elevated to the star's altitude, I observe the time of transit of the star (Epsilon) Pegasi to check the reading of my watch which reads approximate Pacific War Time.

Star: 26/52 2.5

(Epsilon) Pegasi

 $+9^{\circ} 37.4'$

Watch time of transit	8h 35m 17s
Gr. m.t. star's transit Oct. 16	8h 01m 00s
Reduce to " 25	- 35 24
Reduces to long. $122^{\circ} 39'$ W.	- 1 20
Star's transit, l.m.t.	7h 24m 16s
Reduce to P.W.T.	1 10 36
Pacific War Time of star's transit	8h 34m 52s
Watch fast of Pacific War Time	0m 25s

1. The first of these is the

second of these is the

third of these is the

fourth of these is the

fifth of these is the

sixth of these is the

seventh of these is the

eighth of these is the

ninth of these is the

tenth of these is the

eleventh of these is the

twelfth of these is the

thirteenth of these is the

fourteenth of these is the

fifteenth of these is the

sixteenth of these is the

seventeenth of these is the

eighteenth of these is the

nineteenth of these is the

twentieth of these is the

twenty-first of these is the

twenty-second of these is the

twenty-third of these is the

twenty-fourth of these is the

twenty-fifth of these is the

twenty-sixth of these is the

twenty-seventh of these is the

twenty-eighth of these is the

twenty-ninth of these is the

thirtieth of these is the

thirty-first of these is the

thirty-second of these is the

thirty-third of these is the

thirty-fourth of these is the

thirty-fifth of these is the

thirty-sixth of these is the

thirty-seventh of these is the

Meridian Altitude Observation of the Sun for Latitude

Example of meridian altitude observation of the sun for latitude, sun south declination:

October 27, 1944.

Observer: George W. Johnson.

Instrument: Buff No. 14187.

Collimator test of vertical circle, September 5, 1944:

Telescope direct, sights OK at zero	0° 00' 00"
Telescope reversed, sights high at zero	0° 01' 00"
Mean index correction	-0' 30"
At true vertical angle	+ 40° 00' 00"
Mean corrected value	40° 00' 30"
Mean index correction	-0' 30"
	0° 00'

Final Field Notes

October 27, 1944, at the cor. of secs. 32 and 33, on the S. bdy. of T. 1 S., R. 27 W., 5th Prin. Mer., Arkansas, in approximate latitude 34° 36' N., and longitude 93° 54' W., I make a meridian observation of the sun for latitude, observing the altitude of the sun's lower limb with the telescope in direct position, reversing the telescope and observing the sun's upper limb:

Apparent time of observation, noon	= 12h 00m 00s
Mean observed altitude	= 42° 30' 00"
Reduced latitude	= 34° 36' 03"

Field Record.

Setting:

Latitude	90° 00'
Declination	34° 36' N.
	12° 55' S.
Lower limb	42° 29'
Upper limb	42° 13'

Observed alt., lower limb, tel. dir. = 42° 13' 30"

Observed alt., upper limb, tel. rev. = 42° 46' 30"

Mean observed altitude, v	= 42° 30' 00"
Transit index correction	= -0' 30"
Refraction (El.=1000 ft.; temp.=40° F.)	= -1' 03"
Parallax	= +0' 08"

Decl., Gr. app. noon =	12° 50' 05.0"S.	
Reduced to long. 93° 54'		
6.26 x 50.69" = 317.3"	- 5' 17.3"	12° 55' 22.5"S.

Latitude = 34° 36' 03" N. = 90° - decl. - h = 34° 36' 03"
90° 00' 00"

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS

REPORT OF THE
 COMMITTEE ON THE
 PHYSICS OF THE
 ATOM

FOR THE
 YEAR 1955-1956

CHICAGO, ILLINOIS
 1956

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 5640 S. UNIVERSITY AVE.
 CHICAGO, ILL. 60637

REPORT OF THE
 COMMITTEE ON THE
 PHYSICS OF THE
 ATOM

FOR THE
 YEAR 1955-1956

0 - 2

Date - May 30, 1944

Observer - F. W. Williamson

Instrument - W. and L. S.

Gurley No. 38105

May 30, 1944, at U.S.L.M. No. 2383, Iliamna, Alaska, in approximate longitude $154^{\circ}51'$ West, I make a meridian observation of the sun for latitude, observing the altitude of the sun's lower limb with telescope in direct position, reversing the transit and observing the sun's upper limb.

Apparent time of observation noon

12 h 00 m 00 s

Mean observed altitude

 $52^{\circ}07'15''$

Reduced latitude

 $59^{\circ}44'51''$

Field Record.

q

observed altitude lower limb direct

 $51^{\circ}51'00''$

b

observed altitude upper limb reversed

 $52^{\circ}23'30''$

Mean altitude sun's center

 $52^{\circ}07'15''$ $40''$

Altitude corrected for parallax and refraction

 $52^{\circ}06'35''$

Declination apparent noon Greenwich May 30
correction for longitude $154^{\circ}51'$ or
10.32 hrs.

 $21^{\circ}47'57''$ $3'19''$ $21^{\circ}51'26''$ $90^{\circ}00'00''$ $21^{\circ}51'26''$ $111^{\circ}51'26''$ $52^{\circ}06'35''$ $59^{\circ}44'51''$ North latitude.

1. The first part of the report is a general introduction to the subject of the study.

2. The second part of the report is a detailed description of the methods used in the study.

3. The third part of the report is a discussion of the results of the study.

4. The fourth part of the report is a conclusion and a list of references.

5. The fifth part of the report is a list of appendices.

6. The sixth part of the report is a list of figures and tables.

7. The seventh part of the report is a list of footnotes.

8. The eighth part of the report is a list of acknowledgments.

E - 1

Example.

Date: September 10, 1944.

Instruments: Gurley No. 371013.

Observer: Russell C. MacDonald.

Sec. 75: Meridian Observation of the Sun for Time and Latitude.

September 10, 1944, in approximate latitude $41^{\circ} 35' N.$, and longitude $109^{\circ} 58.3' W.$, and at an elevation of 6500 feet above sea level, I make a meridian observation of the sun for time and latitude, observing simultaneously the altitude of the sun's lower limb and the transit of the sun's west limb, reversing the telescope and observing the sun's upper limb and the transit of the sun's east limb.

Mean observed altitude $53^{\circ} 11' 45''$
 Reduced latitude $41^{\circ} 35' 09''$
 Mean watch time of observation 11h 57m 22s
 Watch fast of local mean time 33s

Sun's declination, Greenwich apparent noon, Sept. 10, ... $4^{\circ} 53' 18.7'' N.$
 Reduced to longitude $109^{\circ} 58.3' W.$, $7.332h \times 56.88'' = 416'' = 6' 56.0'' (8.)$

The sun's apparent declination $4^{\circ} 46' 22.7'' N.$

Settings:

$$\nabla \neq 90^{\circ} - \phi + d$$

$\phi \neq (-)$ $90^{\circ} 00'$
 $d \neq (+)$ $4^{\circ} 46'$
 $\nabla \neq$ $53^{\circ} 11'$

Lower limb $52^{\circ} 55'$
 Upper limb $53^{\circ} 27'$

Position of Telescope	Position of Sun	Watch Time of Transit	Observed Vertical Angle
Direct	\oplus	11h 56m 18s	$52^{\circ} 55' 30''$
Reversed	\ominus	11h 58m 26s	$53^{\circ} 28' 00''$

Mean 11h 57m 22s $53^{\circ} 11' 45''$

Refraction, corr. to elev. of 6500 ft. - $\frac{34}{4}''$

Parallax + $05''$

h $53^{\circ} 11' 16''$

decl. = $4^{\circ} 46' 23''$; $90^{\circ} + d$ $94^{\circ} 46' 23''$

$\phi = 41^{\circ} 35.15' N.$; $90^{\circ} + d - h$ $41^{\circ} 35' 07''$

Equation of time, Sept. 10, 1944, Greenwich noon (subt) $3m 03.9s$

Correction to noon, long. $109^{\circ} 58.3' W.$, $06.7s$

Equation of time $3m 11s$

Watch time of apparent noon 11h 57m 22s

Apparent noon 12h 00m 00s

Equation of time ... - $3m 11s$

Local mean time of apparent noon 11h 56m 49s

Watch fast of local mean time 33s

1. The first part of the report

2. The second part of the report

3. The third part of the report

4. The fourth part of the report

5. The fifth part of the report

6. The sixth part of the report

7. The seventh part of the report

8. The eighth part of the report

9. The ninth part of the report

10. The tenth part of the report

11. The eleventh part of the report

12. The twelfth part of the report

13. The thirteenth part of the report

14. The fourteenth part of the report

15. The fifteenth part of the report

E - 2

MERIDIAN OBSERVATION OF THE SUN FOR TIME AND LATITUDE.

Date: Aug. 27, 1944

Observer: A.W. Brown
Recorder: W.H. Teller
Timer: W.H. TellerInstrument: Buff No. 23²15

FINAL FIELD NOTES

Aug. 27, 1944, in camp in sec. 19, T. 45 N., R. 5 E., N.M.P.M., Colo. in latitude $38^{\circ} 08'$ N., longitude $106^{\circ} 21.1'$ W., barometer 22.1 ins. and approx. temperature 77° F., I make a meridian observation of the sun for time and latitude, observing simultaneously the altitude of the sun's upper limb and time of transit of the sun's west limb; then reversing the telescope and observing simultaneously the altitude of the sun's lower limb and time of transit of the sun's east limb.

Mean observed altitude = $61^{\circ} 47' 00''$ Reduced latitude $(90^{\circ} - h + \delta) = 38^{\circ} 08' 13.5''$

Mean watch time of obsn. (M.W.T.) = 1h7m2s.

Watch fast of local mean time = 1h5m40s.

FIELD RECORD

Setting $90^{\circ} 00'$
 $\beta \pm 38^{\circ} 08' \text{ N.}$
 $\delta \pm 9^{\circ} 55' \text{ N.}$
 $v \pm 61^{\circ} 47' (90^{\circ} - \beta + \delta)$
 Upper limb: $62^{\circ} 03' (v + 16')$
 Lower limb: $61^{\circ} 31' (v - 16')$

FIELD OBSERVATION

Telescope	Sun	watch time of sun's transit (m.w.t.)	Observed vertical angle	Barometer ins.	Temp. $^{\circ}$ F.
Direct		1h5m38s. p.m.	$62^{\circ} 03' 00''$	22.1	77
Reversed		1h5m38s. p.m.	$61^{\circ} 31' 00''$		
Mean		1h7m2s. p.m.	$61^{\circ} 47' 00''$		

LATITUDE CALCULATION

Observed vertical angle = $61^{\circ} 47' 00''$ Refraction, $(30.9 \times .75 \times .95) \sin 0^{\circ} 22''$ Parallax = $4.0''$ $h = 61^{\circ} 46' 42.0''$ Sun's decl., Gr. app. t., noon = $10^{\circ} 01' 08.6'' \text{ N.}$ Diff. for 1 hr. = $-52.64''$ Reduction to long. $106^{\circ} 21.2'$ = $6' 13.1'' \text{ E.}$ δ , decl. at time of observation = $9^{\circ} 54' 55.5'' \text{ N.}$ $\beta = 90^{\circ} - h + \delta = 38^{\circ} 08' 13.5'' \text{ N.}$

TIME CALCULATION

Watch time of apparent noon = 1h7m2s. p.m.

Apparent noon = 12h00m00s.

Equation of time = 1m22s.

Local mean time of app. noon = 12h1m22s. p.m.

Watch fast of l.m.t. = 1h5m40s.

THE UNITED STATES OF AMERICA
 DEPARTMENT OF THE ARMY
 OFFICE OF THE CHIEF OF STAFF
 WASHINGTON, D. C.

MEMORANDUM FOR THE CHIEF OF STAFF
 SUBJECT: [Illegible]

1. [Illegible]

2. [Illegible]

3. [Illegible]

4. [Illegible]

5. [Illegible]

6. [Illegible]

7. [Illegible]

[Illegible]	[Illegible]	[Illegible]	[Illegible]
[Illegible]	[Illegible]	[Illegible]	[Illegible]
[Illegible]	[Illegible]	[Illegible]	[Illegible]

8. [Illegible]

9. [Illegible]

10. [Illegible]

11. [Illegible]

12. [Illegible]

13. [Illegible]

14. [Illegible]

E - 3

MERIDIAN OBSERVATION OF A STAR
FOR TIME AND LATITUDE.

Date: Aug. 29, 1944

Observer: A. J. Brown
Recorder: W. H. Teller
Timer: W. H. Teller

Instrument: Buff No 23815

FINAL FIELD NOTES

Aug. 29, 1944, in camp in sec. 19, T. 45 N., R. 5 E., W.M.P.M., Colo., in latitude $38^{\circ} 08' N.$, longitude $106^{\circ} 21.1' W.$, barometer 22.1 ins. and approx. temperature $50^{\circ} F.$. I make a meridian observation of the star $24/48$, sigma sagittarii, observing simultaneously the altitude and time of transit, then reversing the transit telescope and observing the altitude.

Mean observed altitude = $25^{\circ} 31' 30''$
 Reduced latitude ($90 - h - s$) = $38^{\circ} 07' 58''$
 Watch time of observation (m.w.t.) = 9h 24m 42s. p.m.
 Watch fast of local mean time = 1h 6m 0s.

FIELD RECORD

Setting $90^{\circ} 00'$
 $\phi \neq 38^{\circ} 08' N.$
 $s \neq 26^{\circ} 22' S.$
 $v \neq 25^{\circ} 30'$
 $t \neq 9h 25m p.m., m.w.t.$

OBSERVATION

Telescope	Watch time of star's transit (M.W.T.)	Observed vertical angle	Barometer ins.	Lat. Temp. °F.
Direct	9h 24m 42s	$25^{\circ} 31' 30''$	22.1	60
Reversed		$25^{\circ} 31' 30''$	22.1	60
Mean	9h 24m 42s	$25^{\circ} 31' 30''$	22.1	60

LATITUDE CALCULATION

Observed vertical angle = $25^{\circ} 31' 30''$
 Refraction: $(2.0 \times .75 \times .98) = -1' 28''$
 $h = 25^{\circ} 30' 02''$
 $s = \text{sigma sagittarii} = 26^{\circ} 22' 00'' S.$
 $\phi = 90^{\circ} - h - s = 38^{\circ} 07' 58'' N.$

TIME CALCULATION

Watch time of star's transit = 9h 24m 42s.
 Gr. mean time of star's tran. = 8h 19m 54s.
 Correction for long. $106^{\circ} 21.1' = -1h 15m 12s.$ = $-1^m 09^s$
 L.M.T. of star's transit = 8h 18m 42s. 0h 16m 15s
 Watch fast of L.M.T.: 1h 6m 00s. 1h 5m 57s

and the other two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

TABLE 1			
Summary of the results of the experiments			
Experiment	Number of subjects	Number of trials	Number of correct responses
1	10	100	80
2	10	100	80
3	10	100	80
4	10	100	80
5	10	100	80
6	10	100	80
7	10	100	80
8	10	100	80
9	10	100	80
10	10	100	80

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

The first two are the same as the first two.

E - 4

Example.

Date: September 10, 1944.

Instrument: Gurley No. 371613.

Observer: Russell C. MacDonald.

Sec. 75A: Meridian Transit of a Star for Watch Correction
in Local Mean Time, and Latitude.

September 10, 1944, in approximate latitude $41^{\circ} 35' N.$, and longitude $109^{\circ} 58.3' W.$, and at an elevation of 6500 feet above sea level, I make a meridian observation of σ Sagittarii for watch correction in local mean time, and latitude, observing simultaneously the altitude and transit of the star, reversing the telescope and observing the altitude of the star.

Mean observed altitude $22^{\circ} 04' 15''$
 Reduced latitude $41^{\circ} 35' 09''$
 Watch time of star's transit 7h 31m 56s p.m.
 Watch fast of local mean time ... 32s

σ Sagittarii: declination $26^{\circ} 22.0' S.$, Magnitude 2.1 No. 2448

Greenwich mean time of transit 8h 08.0m p.m.
 Correction to September 10 - 35.4m
 Sidereal conversion to longitude $109^{\circ} 58.3' W.$ - 1.2m

Local mean time of star's transit 7h 31.4m p.m.

Setting: $\nabla \neq 90^{\circ} - \delta - d$

$\delta \neq (-) \quad 90^{\circ} 00'$
 $d \neq (-) \quad 41^{\circ} 35'$
 $\quad \quad \quad 26^{\circ} 22'$
 $\nabla \neq \quad 22^{\circ} 03'$

Position of Telescope	Watch Time of Transit	Observed Vertical Angle
Direct	7h 31m 56s p.m.	$22^{\circ} 04' 30''$
Reversed		$22^{\circ} 05' 00''$

Mean 7h 31m 56s p.m. $22^{\circ} 04' 15''$
 Refraction, corr. to elev. of 6500 feet,
 $2'' 22'' \times 0.80$ (coeff.) - $1' 54''$

h $22^{\circ} 02' 51''$
 $d = 26^{\circ} 22' S.; 90^{\circ} - d$ $63^{\circ} 38' 00''$

$\delta = 41^{\circ} 35' N.; 90^{\circ} - d - h$ $41^{\circ} 35' 09''$

Watch time of star's transit 7h 31m 56s p.m.
 Local mean time of star's transit 7h 31m 24s p.m.
 Watch fast of local mean time 32s

1947-1948, 1949-1950, 1951-1952, 1953-1954, 1955-1956, 1957-1958, 1959-1960, 1961-1962, 1963-1964, 1965-1966, 1967-1968, 1969-1970, 1971-1972, 1973-1974, 1975-1976, 1977-1978, 1979-1980, 1981-1982, 1983-1984, 1985-1986, 1987-1988, 1989-1990, 1991-1992, 1993-1994, 1995-1996, 1997-1998, 1999-2000, 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013-2014, 2015-2016, 2017-2018, 2019-2020, 2021-2022, 2023-2024, 2025-2026, 2027-2028, 2029-2030, 2031-2032, 2033-2034, 2035-2036, 2037-2038, 2039-2040, 2041-2042, 2043-2044, 2045-2046, 2047-2048, 2049-2050, 2051-2052, 2053-2054, 2055-2056, 2057-2058, 2059-2060, 2061-2062, 2063-2064, 2065-2066, 2067-2068, 2069-2070, 2071-2072, 2073-2074, 2075-2076, 2077-2078, 2079-2080, 2081-2082, 2083-2084, 2085-2086, 2087-2088, 2089-2090, 2091-2092, 2093-2094, 2095-2096, 2097-2098, 2099-2100, 2101-2102, 2103-2104, 2105-2106, 2107-2108, 2109-2110, 2111-2112, 2113-2114, 2115-2116, 2117-2118, 2119-2120, 2121-2122, 2123-2124, 2125-2126, 2127-2128, 2129-2130, 2131-2132, 2133-2134, 2135-2136, 2137-2138, 2139-2140, 2141-2142, 2143-2144, 2145-2146, 2147-2148, 2149-2150, 2151-2152, 2153-2154, 2155-2156, 2157-2158, 2159-2160, 2161-2162, 2163-2164, 2165-2166, 2167-2168, 2169-2170, 2171-2172, 2173-2174, 2175-2176, 2177-2178, 2179-2180, 2181-2182, 2183-2184, 2185-2186, 2187-2188, 2189-2190, 2191-2192, 2193-2194, 2195-2196, 2197-2198, 2199-2200, 2201-2202, 2203-2204, 2205-2206, 2207-2208, 2209-2210, 2211-2212, 2213-2214, 2215-2216, 2217-2218, 2219-2220, 2221-2222, 2223-2224, 2225-2226, 2227-2228, 2229-2230, 2231-2232, 2233-2234, 2235-2236, 2237-2238, 2239-2240, 2241-2242, 2243-2244, 2245-2246, 2247-2248, 2249-2250, 2251-2252, 2253-2254, 2255-2256, 2257-2258, 2259-2260, 2261-2262, 2263-2264, 2265-2266, 2267-2268, 2269-2270, 2271-2272, 2273-2274, 2275-2276, 2277-2278, 2279-2280, 2281-2282, 2283-2284, 2285-2286, 2287-2288, 2289-2290, 2291-2292, 2293-2294, 2295-2296, 2297-2298, 2299-2300, 2301-2302, 2303-2304, 2305-2306, 2307-2308, 2309-2310, 2311-2312, 2313-2314, 2315-2316, 2317-2318, 2319-2320, 2321-2322, 2323-2324, 2325-2326, 2327-2328, 2329-2330, 2331-2332, 2333-2334, 2335-2336, 2337-2338, 2339-2340, 2341-2342, 2343-2344, 2345-2346, 2347-2348, 2349-2350, 2351-2352, 2353-2354, 2355-2356, 2357-2358, 2359-2360, 2361-2362, 2363-2364, 2365-2366, 2367-2368, 2369-2370, 2371-2372, 2373-2374, 2375-2376, 2377-2378, 2379-2380, 2381-2382, 2383-2384, 2385-2386, 2387-2388, 2389-2390, 2391-2392, 2393-2394, 2395-2396, 2397-2398, 2399-2400, 2401-2402, 2403-2404, 2405-2406, 2407-2408, 2409-2410, 2411-2412, 2413-2414, 2415-2416, 2417-2418, 2419-2420, 2421-2422, 2423-2424, 2425-2426, 2427-2428, 2429-2430, 2431-2432, 2433-2434, 2435-2436, 2437-2438, 2439-2440, 2441-2442, 2443-2444, 2445-2446, 2447-2448, 2449-2450, 2451-2452, 2453-2454, 2455-2456, 2457-2458, 2459-2460, 2461-2462, 2463-2464, 2465-2466, 2467-2468, 2469-2470, 2471-2472, 2473-2474, 2475-2476, 2477-2478, 2479-2480, 2481-2482, 2483-2484, 2485-2486, 2487-2488, 2489-2490, 2491-2492, 2493-2494, 2495-2496, 2497-2498, 2499-2500, 2501-2502, 2503-2504, 2505-2506, 2507-2508, 2509-2510, 2511-2512, 2513-2514, 2515-2516, 2517-2518, 2519-2520, 2521-2522, 2523-2524, 2525-2526, 2527-2528, 2529-2530, 2531-2532, 2533-2534, 2535-2536, 2537-2538, 2539-2540, 2541-2542, 2543-2544, 2545-2546, 2547-2548, 2549-2550, 2551-2552, 2553-2554, 2555-2556, 2557-2558, 2559-2560, 2561-2562, 2563-2564, 2565-2566, 2567-2568, 2569-2570, 2571-2572, 2573-2574, 2575-2576, 2577-2578, 2579-2580, 2581-2582, 2583-2584, 2585-2586, 2587-2588, 2589-2590, 2591-2592, 2593-2594, 2595-2596, 2597-2598, 2599-2600, 2601-2602, 2603-2604, 2605-2606, 2607-2608, 2609-2610, 2611-2612, 2613-2614, 2615-2616, 2617-2618, 2619-2620, 2621-2622, 2623-2624, 2625-2626, 2627-2628, 2629-2630, 2631-2632, 2633-2634, 2635-2636, 2637-2638, 2639-2640, 2641-2642, 2643-2644, 2645-2646, 2647-2648, 2649-2650, 2651-2652, 2653-2654, 2655-2656, 2657-2658, 2659-2660, 2661-2662, 2663-2664, 2665-2666, 2667-2668, 2669-2670, 2671-2672, 2673-2674, 2675-2676, 2677-2678, 2679-2680, 2681-2682, 2683-2684, 2685-2686, 2687-2688, 2689-2690, 2691-2692, 2693-2694, 2695-2696, 2697-2698, 2699-2700, 2701-2702, 2703-2704, 2705-2706, 2707-2708, 2709-2710, 2711-2712, 2713-2714, 2715-2716, 2717-2718, 2719-2720, 2721-2722, 2723-2724, 2725-2726, 2727-2728, 2729-2730, 2731-2732, 2733-2734, 2735-2736, 2737-2738, 2739-2740, 2741-2742, 2743-2744, 2745-2746, 2747-2748, 2749-2750, 2751-2752, 2753-2754, 2755-2756, 2757-2758, 2759-2760, 2761-2762, 2763-2764, 2765-2766, 2767-2768, 2769-2770, 2771-2772, 2773-2774, 2775-2776, 2777-2778, 2779-2780, 2781-2782, 2783-2784, 2785-2786, 2787-2788, 2789-2790, 2791-2792, 2793-2794, 2795-2796, 2797-2798, 2799-2800, 2801-2802, 2803-2804, 2805-2806, 2807-2808, 2809-2810, 2811-2812, 2813-2814, 2815-2816, 2817-2818, 2819-2820, 2821-2822, 2823-2824, 2825-2826, 2827-2828, 2829-2830, 2831-2832, 2833-2834, 2835-2836, 2837-2838, 2839-2840, 2841-2842, 2843-2844, 2845-2846, 2847-2848, 2849-2850, 2851-2852, 2853-2854, 2855-2856, 2857-2858, 2859-2860, 2861-2862, 2863-2864, 2865-2866, 2867-2868, 2869-2870, 2871-2872, 2873-2874, 2875-2876, 2877-2878, 2879-2880, 2881-2882, 2883-2884, 2885-2886, 2887-2888, 2889-2890, 2891-2892, 2893-2894, 2895-2896, 2897-2898, 2899-2900, 2901-2902, 2903-2904, 2905-2906, 2907-2908, 2909-2910, 2911-2912, 2913-2914, 2915-2916, 2917-2918, 2919-2920, 2921-2922, 2923-2924, 2925-2926, 2927-2928, 2929-2930, 2931-2932, 2933-2934, 2935-2936, 2937-2938, 2939-2940, 2941-2942, 2943-2944, 2945-2946, 2947-2948, 2949-2950, 2951-2952, 2953-2954, 2955-2956, 2957-2958, 2959-2960, 2961-2962, 2963-2964, 2965-2966, 2967-2968, 2969-2970, 2971-2972, 2973-2974, 2975-2976, 2977-2978, 2979-2980, 2981-2982, 2983-2984, 2985-2986, 2987-2988, 2989-2990, 2991-2992, 2993-2994, 2995-2996, 2997-2998, 2999-3000, 3001-3002, 3003-3004, 3005-3006, 3007-3008, 3009-3010, 3011-3012, 3013-3014, 3015-3016, 3017-3018, 3019-3020, 3021-3022, 3023-3024, 3025-3026, 3027-3028, 3029-3030, 3031-3032, 3033-3034, 3035-3036, 3037-3038, 3039-3040, 3041-3042, 3043-3044, 3045-3046, 3047-3048, 3049-3050, 3051-3052, 3053-3054, 3055-3056, 3057-3058, 3059-3060, 3061-3062, 3063-3064, 3065-3066, 3067-3068, 3069-3070, 3071-3072, 3073-3074, 3075-3076, 3077-3078, 3079-3080, 3081-3082, 3083-3084, 3085-3086, 3087-3088, 3089-3090, 3091-3092, 3093-3094, 3095-3096, 3097-3098, 3099-3100, 3101-3102, 3103-3104, 3105-3106, 3107-3108, 3109-3110, 3111-3112, 3113-3114, 3115-3116, 3117-3118, 3119-3120, 3121-3122, 3123-3124, 3125-3126, 3127-3128, 3129-3130, 3131-3132, 3133-3134, 3135-3136, 3137-3138, 3139-3140, 3141-3142, 3143-3144, 3145-3146, 3147-3148, 3149-3150, 3151-3152, 3153-3154, 3155-3156, 3157-3158, 3159-3160, 3161-3162, 3163-3164, 3165-3166, 3167-3168, 3169-3170, 3171-3172, 3173-3174, 3175-3176, 3177-3178, 3179-3180, 3181-3182, 3183-3184, 3185-3186, 3187-3188, 3189-3190, 3191-3192, 3193-3194, 3195-3196, 3197-3198, 3199-3200, 3201-3202, 3203-3204, 3205-3206, 3207-3208, 3209-3210, 3211-3212, 3213-3214, 3215-3216, 3217-3218, 3219-3220, 3221-3222, 3223-3224, 3225-3226, 3227-3228, 3229-3230, 3231-3232, 3233-3234, 3235-3236, 3237-3238, 3239-3240, 3241-3242, 3243-3244, 3245-3246, 3247-3248, 3249-3250, 3251-3252, 3253-3254, 3255-3256, 3257-3258, 3259-3260, 3261-3262, 3263-3264, 3265-3266, 3267-3268, 3269-3270, 3271-3272, 3273-3274, 3275-3276, 3277-3278, 3279-3280, 3281-3282, 3283-3284, 3285-3286, 3287-3288, 3289-3290, 3291-3292, 3293-3294, 3295-3296, 3297-3298, 3299-3300, 3301-3302, 3303-3304, 3305-3306, 3307-3308, 3309-3310, 3311-3312, 3313-3314, 3315-3316, 3317-3318, 3319-3320, 3321-3322, 3323-3324, 3325-3326, 3327-3328, 3329-3330, 3331-3332, 3333-3334, 3335-3336, 3337-3338, 3339-3340, 3341-3342, 3343-3344, 3345-3346, 3347-3348, 3349-3350, 3351-3352, 3353-3354, 3355-3356, 3357-3358, 3359-3360, 3361-3362, 3363-3364, 3365-3366, 3367-3368, 3369-3370, 3371-3372, 3373-3374, 3375-3376, 3377-3378, 3379-3380, 3381-3382, 3383-3384, 3385-3386, 3387-3388, 3389-3390, 3391-3392, 3393-3394, 3395-3396, 3397-3398, 3399-3400, 3401-3402, 3403-3404, 3405-3406, 3407-3408, 3409-3410, 3411-3412, 3413-3414, 3415-3416, 3417-3418, 3419-3420, 3421-3422, 3423-3424, 3425-3426, 3427-3428, 3429-3430, 3431-3432, 3433-3434, 3435-3436, 3437-3438, 3439-3440, 3441-3442, 3443-3444, 3445-3446, 3447-3448, 3449-3450, 3451-3452, 3453-3454, 3455-3456, 3457-3458, 3459-3460, 3461-3462, 3463-3464, 3465-3466, 3467-3468, 3469-3470, 3471-3472, 3473-3474, 3475-3476, 3477-3478, 3479-3480, 3481-3482, 3483-3484, 3485-3486, 3487-3488, 3489-3490, 3491-3492, 3493-3494, 3495-3496, 3497-3498, 3499-3500, 3501-3502, 3503-3504, 3505-3506, 3507-3508, 3509-3510, 3511-3512, 3513-3514, 3515-3516, 3517-3518, 3519-3520, 3521-3522, 3523-3524, 3525-3526, 3527-3528, 3529-3530, 3531-3532, 3533-3534, 3535-3536, 3537-3538, 3539-3540, 3541-3542, 3543-3544, 3545-3546, 3547-3548, 3549-3550, 3551-3552, 3553-3554, 3555-3556, 3557-3558, 3559-3560, 3561-3562, 3563-3564, 3565-3566, 3567-3568, 3569-3570, 3571-3572, 3573-3574, 3575-3576, 3577-3578, 3579-3580, 3581-3582, 3583-3584, 3585-3586, 3587-3588, 3589-3590, 3591-3592, 3593-3594, 3595-3596, 3597-3598, 3599-3600, 3601-3602, 3603-3604, 3605-3606, 3607-3608, 3609-3610, 3611-3612, 3613-3614, 3615-3616, 3617-3618, 3619-3620, 3621-3622, 3623-3624, 3625-3626, 3627-3628, 3629-3630, 3631-3632, 3633-3634, 3635-3636, 3637-3638, 3639-3640, 3641-3642, 3643-3644, 3645-3646, 3647-3648, 3649-3650, 3651-3652, 3653-3654, 3655-3656, 3657-3658, 3659-3660, 3661-3662, 3663-3664, 3665-3666, 3667-3668, 3669-3670, 3671-3672, 3673-3674, 3675-3676, 3677-3678, 3679-3680, 3681-3682, 3683-3684, 3685-3686, 3687-3688, 3689-3690, 3691-3692, 3693-3694, 3695-3696, 3697-3698, 3699-3700, 3701-3702, 3703-3704, 3705-3706, 3707-3708, 3709-3710, 3711-3712, 3713-3714, 3715-3716, 3717-3718, 3719-3720, 3721-3722, 3723-3724, 3725-3726, 3727-3728, 3729-3730, 3731-3732, 3733-3734, 3735-3736, 3737-3738, 3739-3740, 3741-3742, 3743-3744, 3745-3746, 3747-3748, 3749-3750, 3751-3752, 3753-3754, 3755-3756, 3757-3758, 3759-3760, 3761-3762, 3763-3764, 3765-3766, 3767-3768, 3769-3770, 3771-3772, 3773-3774, 3775-3776, 3777-3778, 3779-3780, 3781-3782, 3783-3784, 3785-3786, 3787-3788, 3789-3790, 3791-3792, 3793-3794, 3795-3796, 3797-3798, 3799-3800, 3801-3802, 3803-3804, 3805-3806, 3807-3808, 3809-3810, 3811-3812, 3813-3814, 3815-3816, 3817-3818, 3819-3820, 3821-3822, 3823-3824, 3825-3826, 3827-3828, 3829-3830, 3831-3832, 3833-3834, 3835-3836, 3837-3838, 3839-3840, 3841-3842, 3843-3844, 3845-3846, 3847-3848, 3849-3850, 3851-3852, 3853-3854, 3855-3856, 3857-3858, 3859-3860, 3861-3862, 3863-3864, 3865-3866, 3867-3868, 3869-3870, 3871-3872, 3873-3874, 3875-3876, 3877-3878, 3879-3880, 3881-3882, 3883-3884, 3885-3886, 3887-3888, 3889-3890, 3891-3892, 3893-3894, 3895-3896, 3897-3898, 3899-3900, 3901-3902, 3903-3904, 3905-3906, 3907-3908, 3909-3910, 3911-3912, 3913-3914, 3915-3916, 3917-3918, 3919-3920, 3921-3922, 3923-3924, 3925-3926, 3927-3928, 3929-3930, 3931-3932, 3933-3934, 3935-3936, 3937-3938, 3939-3940, 3941-3942, 3943-3944, 3945-3946, 3947-3948, 3949-3950, 3951-3952, 3953-3954, 3955-3956, 3957-3958, 3959-3960, 3961-3962, 3963-3964, 3965-3966, 3967-3968, 3969-3970, 3971-3972, 3973-3974, 3975-3976, 3977-3978, 3979-3980, 3981-3982, 3983-3984, 3985-3986, 3987-3988, 3989-3990, 3991-3992, 3993-3994, 3995-3996, 3997-3998, 3999-4000, 4001-4002, 4003-4004, 4005-4006, 4007-4008, 4009-4010, 4011-4012, 4013-4014, 4015-4016, 4017-4018, 4019-4020, 4021-4022, 4023-4024, 4025-4026, 4027-4028, 4029-4030, 4031-4032, 4033-4034, 4035-4036, 4037-4038, 4039-4040, 4041-4042, 4043-4044, 4045-4046, 4047-4048, 4049-4050, 4051-4052, 4053-4054, 4055-4056, 4057-4058, 4059-4060, 4061-4062, 4063-4064, 4065-4066, 4067-4068, 4069-4070, 4071-4072, 4073-4074, 4075-4076, 4077-4078, 4079-4080, 4081-4082, 4083-4084, 4085-4086, 4087-4088, 4089-4090, 4091-4092, 4093-4094, 4095-4096, 4097-4098, 4099-4100, 4101-4102, 4103-4104, 4105-4106, 4107-4108, 4109-4110, 4111-4112, 4113-4114, 4115-4116, 4117-4118, 4119-4120, 4121-4122, 4123-4124, 4125-4126, 4127-4128, 4129-4130, 4131-4132, 4133-4134, 4135-4136, 4137-4138, 4139-4140, 4141-4142, 4143-4144, 4145-4146, 4147-4148, 4149-4150, 4151-4152, 4153-4154, 4155-4156, 4157-4158, 4159-4160, 4161-4162, 4163-4164, 4165-4166, 4167-4168, 4169-4170, 4171-4172, 4173-4174, 4175-4176, 4177-4178, 4179-4180, 4181-4182, 4183-4184, 4185-4186, 418

Example of altitude observation of Polaris at Upper
Culmination for latitude:

Observer: Glenn R. Haste

Final field notes.

August 31, 1944, in approximate latitude $33^{\circ} 23' N.$, and
longitude $107^{\circ} 11' 38'' W.$, I make an altitude observation on
Polaris at upper culmination for latitude, making four ob-
servations, two each with the telescope in direct and reverse-
ed positions.

Watch set correct mountain war time
by radio signal.

Mean watch time of observation

= 4h 17m 01s a.m.

Mean observed vertical angle

= $34^{\circ} 24' 52''$

Reduced latitude

= $33^{\circ} 23' 14'' N.$

Field record.

Setting: $90^{\circ} 00'$

$d = 89^{\circ} 00'$

$90^{\circ} - d = 1^{\circ} 00'$

$\phi = 33^{\circ} 23'$

$\psi = 34^{\circ} 23'$ $\phi + (90^{\circ} - d)$

Gr. U. C. of Polaris, August 31, 1944

= 3h 09.5m

Reduced to longitude $107^{\circ} 11'.6 W.$

= - 1.2

3h 08.3m

L. M. T. of U. C. of Polaris, August 31

= 3h 08m 24s

War time fast of standard time

= 1h 00m 00s

Correction for longitude $107^{\circ} 11' 38''$

= 0h 08m 47s

Computed watch time of upper culmination

= 4h 17m 11s

Telescope	Watch time.	Vertical angle.
Direct -----	4h 13m 03s	$34^{\circ} 24' 00''$
Reversed -----	4h 15m 01s	$34^{\circ} 26' 00''$
Reversed -----	4h 19m 00s	$34^{\circ} 26' 50''$
Direct -----	4h 21m 00s	$34^{\circ} 23' 00''$
Mean -----	4h 17m 01s	$34^{\circ} 24' 52''$
Refraction (cor. for elev. 3500') -		- 1' 15"
		$h = 34^{\circ} 23' 37''$
$d = 88^{\circ} 59' 47''$; $90^{\circ} - d$ -----		= $1^{\circ} 00' 13''$
$\phi = 33^{\circ} 23' 14''$; $h = h + (90^{\circ} - d)$ -----		$F = 33^{\circ} 23' 24''$

F - 2

ALTITUDE OBSERVATION OF POLARIS AT UPPER CULMINATION FOR LATITUDE

Date: Oct. 18, 1944. Observer: Elliot Bird Instrument: Buff No. 18003.

In approximate latitude $40^{\circ}44'$ N., longitude $111^{\circ}52'$ W., I make an altitude observation on Polaris at upper culmination for latitude, making four observations, two each with the telescope in direct and reversed positions.

Watch carries correct 105th meridian standard war time, having been compared with Western Union time signals broadcast hourly over radio station K S L, Salt Lake City, Utah.

Setting:

$$\begin{array}{rcl}
 & & 90^{\circ} 00' \\
 90^{\circ} & = & \delta + \frac{40^{\circ} 44'}{130^{\circ} 44'} \\
 & & \delta + \frac{80^{\circ} 00'}{41^{\circ} 44'} = \delta + (90^{\circ} - \delta)
 \end{array}$$

Greenwich U.C. of Polaris Oct. 18, 1944	=	0h 1.2m a.m.
Reduction for longitude	=	-1.2m
Local mean time U.C. of Polaris Oct. 17	=	0h 0.0m (midnight)
Correction for longitude $111^{\circ}52'$ W.	=	+27m 28s
Correction for war time	=	1h 00m 00s
Computed watch time of U.C. Oct. 18	=	1h 27m 28s a.m.

Telescope	Watch time	Vertical angle
Direct.....	1h 23m 4s	$41^{\circ} 44' 30''$
Reversed.....	1h 27m 7s	$41^{\circ} 45' 00''$
Reversed.....	1h 30m 2s	$41^{\circ} 45' 00''$
Direct.....	1h 33m 7s	$41^{\circ} 44' 30''$
Mean.....	1h 28m 20s	$41^{\circ} 44' 45''$
Refraction.....		-1' 5"
		$h = 41^{\circ} 43' 40''$
$\delta = 89^{\circ}00'03''$; $90^{\circ} - \delta$		$= -59' 57''$
$\phi = 40^{\circ}43'.7$ N. $= h + \delta - 90^{\circ}$		$= 40^{\circ} 43' 43''$

MEMO:

Refraction corrected for elevation above sea level (4500 ft.) as follows:

Observed vertical angle	=	$41^{\circ} 44' 45''$
Refraction ($1' 05'' \times .86 = 56''$)	=	-56
	$h =$	$41^{\circ} 43' 49''$
$\delta = 89^{\circ} 00' 03''$; $90^{\circ} - \delta$	=	59 57
$\phi = 40^{\circ} 43.9' \text{ N.} = h + \delta - 90^{\circ}$	=	$40^{\circ} 43' 52''$

THESE RECHERCHES SONT EN COURS DE PUBLICATION.

LES RECHERCHES SONT EN COURS DE PUBLICATION.

LES RECHERCHES SONT EN COURS DE PUBLICATION.

LES RECHERCHES SONT EN COURS DE PUBLICATION.

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

LES RECHERCHES

Example of Altitude Observation of Polaris at any Hour Angle for Latitude, Sec. 133-A, making use of the table given in the Ephemeris:

Final Field Notes.

June 23, 1944, in the S.H. $\frac{1}{2}$ of sec. 16, T. 7 N., R. 3 E., Salt Lake Meridian, in approximate latitude $41^{\circ} 20' N.$, and longitude $111^{\circ} 37' W.$, I make an altitude observation on Polaris at an hour angle for latitude, making four observations, two each with the telescope in direct and reversed positions:

Mean observed vertical angle	$42^{\circ} 00' 30''$
Mean watch time of observation, a. m.	4h 46m 38s
Watch reads correct 105th meridian standard time, after deducting 1 hour from war time, as determined by radio signals	00m 00s
Reduced latitude	$41^{\circ} 20' 37''$

Field Record

Hour angle observation of Polaris for latitude:

Telescope	Vertical angle.	Watch time.
Direct.....	$41^{\circ} 58' 30''$	4h 44m 45s a. m.
Reversed.....	$41^{\circ} 59' 30''$	4 45 50
Reversed.....	$42^{\circ} 01' 30''$	4 47 20
Direct.....	$42^{\circ} 02' 30''$	4 48 37
Mean.....	$42^{\circ} 00' 30''$	4h 46m 38s a. m.
Watch fast of local mean time or correction for longitude $111^{\circ} 37' W.$		<u>26 28</u>
L. M. T. of observation, June 23, 1944		= 4h 20m 10s a. m.
		= 4h 20.2m a. m.
Gr. U. C. of Polaris, same date	= 7h 39.4m a. m.	
Reduced to longitude $111^{\circ} 37' W.$	= <u>-1.2m</u>	= 7h 38.2m a. m.
Less L. M. T. of observation same date		<u>4 20.2</u>
Argument for table for hour angle of Polaris east of mer.		= 3h 18.0m
Declination of Polaris		= $88^{\circ} 59' 39''$

Mean time hour angle	Primary adjustment, subtractive, Polaris above the pole.	Mean observed vert. ang. $v = 42^{\circ} 00' 30''$	See memo. below.
	Declination.	Correction for refraction = $-01^{\circ} 04'$	
	$88^{\circ} 59' 40''$	$h = 41^{\circ} 59' 26''$	
3h 17.5m	$0^{\circ} 38' 53''$	Primary adjustment to elevation of pole = $-0^{\circ} 38' 47''$	
3 18.0	$0^{\circ} 38' 47''$	Supplemental correction = $-0^{\circ} 0' 02''$	
3 23.4	$0^{\circ} 37' 39''$	Latitude of sta. = $41^{\circ} 20' 37''$	

Determination of the Azimuth from the Mean Time Hour Angle obtained in the Altitude observations of Polaris for Latitude, given in above example:

Mean time hour angle	Azimuth of Polaris.			Correction additive for declination 88° 59' 40"
	Mean Declination. + 89° 00' 00"			
	Latitude			
	40°	41° 20' 37"	42°	
3h 9.5m	58.3'	59.6'	60.2'	0.3'
3 18.0		61.6		0.3
3 19.5	60.6	61.9	62.5	0.3

$$\text{Azimuth of Polaris} = 1^{\circ} 1.6' + 0.3' = 1^{\circ} 1.9' = 1^{\circ} 1' 54''$$

... ..

...

... ..

... ..

...

... ..

... ..

... ..

... ..

... ..

... ..

... ..

...
...
...
...
...

... ..

...
...
...
...
...
...

... ..

... ..

Analytical reduction for Latitude, using the Mean Time Hour Angle and Altitude given in the example on sheet No. 2:

In order to proceed with the analytical reduction, it is convenient to begin with an angle a , computed from the equation:

$$\tan a = \frac{\tan \delta}{\cos t}, \text{ in which equation the factor "cos } t \text{ becomes negative for}$$

hour angles exceeding 90° , whereupon a will exceed 90° .

t = sidereal hour angle counting from the meridian.

$$\delta = 68^\circ 59' 39". \quad h = 41^\circ 59' 26".$$

The latitude is derived from the equation:

$$\cos (\phi - a) = \frac{\sin a \sin h}{\sin \delta}$$

The above example of the field observation is reduced as follows:

Mean time hour angle	3h 18.0m	log tan $\delta = 11.755520$	log sin $a = 9.9999719$
Reduced to sidereal		" cos $t = 9.8113212$	" " $h = 9.8254373$
hour angle add	33s	" tan $a = 1.9442308$	" " $\delta = 9.8254032$
Sidereal hour angle t	3h 18m 33s		" " $a = 9.9999331$
Same reduced to angular measurement t	$= 49^\circ 38' 15"$	log cos $(\phi - a) = 9.8254701$	
		$a = 89^\circ 20' 55"$	

By inspection

$\phi - a$ is a negative angle.

$$\phi - a = -48^\circ 0' 17"$$

$$a = 89^\circ 20' 55"$$

$$\text{Latitude of station} \dots \phi = 41^\circ 20' 38"$$

MEMO:

The refraction correction is adjusted for elevation of station (≈ 6800 ft.) as follows:

Mean observed vertical angle, v	$= 42^\circ 00' 30"$
Refraction corr. ($1' 04'' \times .79 = 51''$)	$= -51$
" h	$= 41^\circ 59' 39"$
Primary adjustment to elev. of pole	$= -38 \quad 47$
" Supplemental correction	$= -02$
Latitude of station, ϕ	$= 41^\circ 20' 50" \text{ N.}$

Latitude by formulas as above, using corrected value for " h ":

M.t.h.a.	3h 18m 00s	log tan $\delta = 11.755520$	log sin $a = 9.9999719$
Red. to s.d. h.a.	$+33$	" cos $t = 9.8113212$	" " $h = 9.8254618$
Sidereal h.a.	3h 18m 33s	" tan $a = 1.9442308$	" " $\delta = 9.8254337$
		" " $a = 89^\circ 20' 55"$	" " $a = 9.9999331$
$t = 49^\circ 38' 15"$		log cos $(\phi - a) = 9.8255006$	
		" " $(\phi - a) = -48^\circ 00' 04"$	
		$a = 89^\circ 20' 55"$	
		$\phi = 41^\circ 20' 51" \text{ N.}$	

Example of hour angle observation of Polaris for latitude:

Observer: Glenn R. Haste.

Final field notes.

Aug. 31, 1944, at the standard cor. of Tps. 10 S., R. 3 and 4 W., in longitude 107° 11' 38" W., I make an hour angle observation of Polaris for latitude, reading two vertical angles, one each with the telescope in direct and reversed positions:

Mean observed vertical angle	34° 15' 45"
Mean watch time of observation, a.m.	6h 22m 32s
Watch fast of l.m.t., determined by radio signal reading mountain war time	1h 08m 47s
Reduced latitude	33° 23' 15"

Field record.

Hour angle observation of Polaris for latitude:

Telescope.	Vertical angle.	Watch time.
Direct -----	34° 16'	6h 22m 10s a.m.
Reversed -----	34° 15' 30"	6h 22m 54s
Mean -----	34° 15' 45"	6h 22m 32s a.m.
Watch fast of local mean time -----		1h 08m 47s
L. M. T. of observation, Aug. 31, 1944		5h 13m 45s a.m.
		5h 13.7m a.m.

Gr. U. C. of Polaris,
same date 3h 09.5m a.m.
Reduced to longitude 107° 11' 38" W. - 1.2 = 3h 08.3m a.m.
Hour angle of Polaris west of the meridian = 2h 05.4m
Declination of Polaris + 88° 59' 46.9"

Mean time hour angle.	Primary adjustment, subtractive, Polaris above the pole.		
	Declination.		
	+88° 59' 40"	+88° 59' 46.9"	+89° 00' 00"
1h 59.7m	0° 52' 07"	0° 52' 01"	0° 51' 50"
2h 05.4		0° 51' 13"	
2h 11.6	0° 50' 27"	0° 50' 21"	0° 50' 10"

Mean observed vertical angle, v	= 34° 15' 45"
Correction for refraction, (elev. 3600 ft. above sea level.)	= 1' 15"
h	= 34° 14' 30"
Primary adjustment to elevation of pole.	= 0° 51' 13"
Supplemental correction	= 0° 00' 02"
Latitude of station.	= 33° 23' 15"

In order to proceed with the analytical reduction, it is convenient to begin with an angle a , computed from the equation:

$\tan a = \cos t$, in which equation the factor " $\cos t$ " becomes negative for hour angles exceeding 90°, whereupon a will exceed 90°. The latitude may then be derived from the equation:

$$\cos(\phi - a) = \frac{\sin a \sin h}{\sin d}$$

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

Page 1 of 1

The above example of a field observation is reduced as follows:

Mean time h.a.	2h 05.4m	log tan d=	1.7565011	log sin a=	9.9999514
		" cos t=	<u>9.9311136</u>	" " h=	<u>9.7502651</u>
Red. to sidereal					
h. a.	+ 0.3	" tan a=	1.8253875	" "	9.7502165
Sidereal h.a.	<u>2h 05.7m</u>			" d=	<u>9.9999337</u>
		a=	89° 08' 37"		
Same, red. to				log cos (p-a)=	<u>9.7502828</u>
ang. meas.,	t= <u>31° 25' 30"</u>				

By inspection it will be seen that $p-a$ is a negative angle.

Latitude of station ----- $p = \underline{\underline{33^{\circ} 23' 13''}}$

THE UNITED STATES OF AMERICA
DO hereby certify that
[Name] is a citizen of the United States
and that he is entitled to the
benefits of the National Defense
Education Act of 1958.
[Signature]
[Title]
[Date]

Date: Nov. 2, 1944.

Observer: R. Y. Lyman. Instrument: Gurley No. 571657.

Field record.		Final field notes.	
Nov. 2, 1944, Gr. N. E. of Polaris, lat. 40' Reduced to long. 111° 33' W. Reduced to lat. 46° 24' N.		Nov. 2, 1944, at the cor. of secs. 1, 2, 11 and 12, T. 7 N., R. 1 E., Prin. Mer., Montana, latitude 46° 24' N., longitude 111° 33' W., at 8 ^h 02.2 ^m p.m., l.m.t., I observe Polaris at eastern elongation, making four observations, two each with the tele- scope in direct and reversed posi- tions, and mark the mean point in the line thus determined, on a peg driven in the ground, 6 chs. N.	
L.m.t. of N. E. of Polaris Watch fast of l.m.t. by radio time signals			
Watch time of N. E.			
Telescope,	Watch time.		
Direct.....	8 ^h 26 ^m 20 ^s p.m.		
Reversed.....	8 26 30		
Reversed.....	8 29 30		
Direct.....	8 30 20		
Mean.....	8 ^h 29 ^m 40 ^s p.m.		
Declination of Polaris 69° 00' 09.5" N.			
Declination.			
Latitude	69° 00' 00"	69° 00' 09"	69° 00' 10"
	Azimuth		
46° 00' 00"	1° 26' 25"	1° 26' 09"	1° 26' 09"
46 24 00		1 26 47	
47 00 00	1 27 59	1 27 45	1 27 44

M - 2

Elongation Observation of Polaris, Observing Program "a."

Observer: Geo. F. Rigby

Recorder: LeRoy V. Wollney

Date: September 9, 1944. Instrument: W. & L. E. Gurley No. 2350

Field Record		Final Field Notes	
Sept. 9, 1944, Gr. E.E. of Polaris, lat. 40°		Sept. 9, 1944, in camp in SE 1/4 sec. 15, T. 35 S., R. 25 E., Willamette Meridian, Oregon, in latitude 42° 32' 24" N., and longitude 119° 46' 30" W., at 8h 33m 38s p.m., I m.t., I observe Polaris at eastern elongation, making four observations, two each with the telescope in direct and reversed positions, and mark the mean point in the line thus determined, on a peg driven firmly in the ground, 10 che. N.	
Red. to long. 119° 46' 30" W.	8h 34m 36s - 1 19		
Red. to lat. 42° 32' 24" N.	+ 0 21		
L.M.T. of E.E. of Polaris	8h 33m 38s		
Watch fast of I.m.t.	0 58 42		
Watch time of E.E.	9h 32m 20s	Azimuth of Polaris at east- ern elongation 1° 21' 41"	
Telescope	Watch time		
Direct	9h 29m 50s p.m.		
Reversed	9 32 07		
Reversed	9 33 34		
Direct	9 35 36	Sept. 10: I lay off the azimuth of Polaris, 1° 21' 41", and make a me- ridian mark on a second peg, 23.77 lks. (15.69 ft.) to the west of the mean point in the line determined by the observation; I verify the angle by a vernier reading of the instru- ment.	
Mean	9 32 47 p.m.		
Declination of Polaris 88° 59' 49"			
Declination		Latitude	
88°59'40" | 88°59'49" | 88°59'50"			
Azimuth			
42°00'00"	1°21'11" | 1°20'59" | 1°20'58"		
42°32'24"	1°21'41"		
43°00'00"	1°22'30" | 1°22'17" | 1°22'16"		

THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION
PUBLISHED WEEKLY
535 N. Dearborn Ave., Chicago, Ill. 60610
Subscription price: \$5.00 per year in advance. Single copies 15¢.
Entered as Second-Class Matter, May 2, 1917. Postpaid at special rate of \$5.00 per year.
Acceptance for mailing at special rate of \$5.00 per year provided for in Act of October 3, 1917.
Copyright, 1968, by American Medical Association

Date	Description
1/1/68	1/1/68
1/2/68	1/2/68
1/3/68	1/3/68
1/4/68	1/4/68
1/5/68	1/5/68
1/6/68	1/6/68
1/7/68	1/7/68
1/8/68	1/8/68
1/9/68	1/9/68
1/10/68	1/10/68
1/11/68	1/11/68
1/12/68	1/12/68
1/13/68	1/13/68
1/14/68	1/14/68
1/15/68	1/15/68
1/16/68	1/16/68
1/17/68	1/17/68
1/18/68	1/18/68
1/19/68	1/19/68
1/20/68	1/20/68
1/21/68	1/21/68
1/22/68	1/22/68
1/23/68	1/23/68
1/24/68	1/24/68
1/25/68	1/25/68
1/26/68	1/26/68
1/27/68	1/27/68
1/28/68	1/28/68
1/29/68	1/29/68
1/30/68	1/30/68
1/31/68	1/31/68
2/1/68	2/1/68
2/2/68	2/2/68
2/3/68	2/3/68
2/4/68	2/4/68
2/5/68	2/5/68
2/6/68	2/6/68
2/7/68	2/7/68
2/8/68	2/8/68
2/9/68	2/9/68
2/10/68	2/10/68
2/11/68	2/11/68
2/12/68	2/12/68
2/13/68	2/13/68
2/14/68	2/14/68
2/15/68	2/15/68
2/16/68	2/16/68
2/17/68	2/17/68
2/18/68	2/18/68
2/19/68	2/19/68
2/20/68	2/20/68
2/21/68	2/21/68
2/22/68	2/22/68
2/23/68	2/23/68
2/24/68	2/24/68
2/25/68	2/25/68
2/26/68	2/26/68
2/27/68	2/27/68
2/28/68	2/28/68
2/29/68	2/29/68
2/30/68	2/30/68
3/1/68	3/1/68
3/2/68	3/2/68
3/3/68	3/3/68
3/4/68	3/4/68
3/5/68	3/5/68
3/6/68	3/6/68
3/7/68	3/7/68
3/8/68	3/8/68
3/9/68	3/9/68
3/10/68	3/10/68
3/11/68	3/11/68
3/12/68	3/12/68
3/13/68	3/13/68
3/14/68	3/14/68
3/15/68	3/15/68
3/16/68	3/16/68
3/17/68	3/17/68
3/18/68	3/18/68
3/19/68	3/19/68
3/20/68	3/20/68
3/21/68	3/21/68
3/22/68	3/22/68
3/23/68	3/23/68
3/24/68	3/24/68
3/25/68	3/25/68
3/26/68	3/26/68
3/27/68	3/27/68
3/28/68	3/28/68
3/29/68	3/29/68
3/30/68	3/30/68
3/31/68	3/31/68
4/1/68	4/1/68
4/2/68	4/2/68
4/3/68	4/3/68
4/4/68	4/4/68
4/5/68	4/5/68
4/6/68	4/6/68
4/7/68	4/7/68
4/8/68	4/8/68
4/9/68	4/9/68
4/10/68	4/10/68
4/11/68	4/11/68
4/12/68	4/12/68
4/13/68	4/13/68
4/14/68	4/14/68
4/15/68	4/15/68
4/16/68	4/16/68
4/17/68	4/17/68
4/18/68	4/18/68
4/19/68	4/19/68
4/20/68	4/20/68
4/21/68	4/21/68
4/22/68	4/22/68
4/23/68	4/23/68
4/24/68	4/24/68
4/25/68	4/25/68
4/26/68	4/26/68
4/27/68	4/27/68
4/28/68	4/28/68
4/29/68	4/29/68
4/30/68	4/30/68
5/1/68	5/1/68
5/2/68	5/2/68
5/3/68	5/3/68
5/4/68	5/4/68
5/5/68	5/5/68
5/6/68	5/6/68
5/7/68	5/7/68
5/8/68	5/8/68
5/9/68	5/9/68
5/10/68	5/10/68
5/11/68	5/11/68
5/12/68	5/12/68
5/13/68	5/13/68
5/14/68	5/14/68
5/15/68	5/15/68
5/16/68	5/16/68
5/17/68	5/17/68
5/18/68	5/18/68
5/19/68	5/19/68
5/20/68	5/20/68
5/21/68	5/21/68
5/22/68	5/22/68
5/23/68	5/23/68
5/24/68	5/24/68
5/25/68	5/25/68
5/26/68	5/26/68
5/27/68	5/27/68
5/28/68	5/28/68
5/29/68	5/29/68
5/30/68	5/30/68
5/31/68	5/31/68
6/1/68	6/1/68
6/2/68	6/2/68
6/3/68	6/3/68
6/4/68	6/4/68
6/5/68	6/5/68
6/6/68	6/6/68
6/7/68	6/7/68
6/8/68	6/8/68
6/9/68	6/9/68
6/10/68	6/10/68
6/11/68	6/11/68
6/12/68	6/12/68
6/13/68	6/13/68
6/14/68	6/14/68
6/15/68	6/15/68
6/16/68	6/16/68
6/17/68	6/17/68
6/18/68	6/18/68
6/19/68	6/19/68
6/20/68	6/20/68
6/21/68	6/21/68
6/22/68	6/22/68
6/23/68	6/23/68
6/24/68	6/24/68
6/25/68	6/25/68
6/26/68	6/26/68
6/27/68	6/27/68
6/28/68	6/28/68
6/29/68	6/29/68
6/30/68	6/30/68
7/1/68	7/1/68
7/2/68	7/2/68
7/3/68	7/3/68
7/4/68	7/4/68
7/5/68	7/5/68
7/6/68	7/6/68
7/7/68	7/7/68
7/8/68	7/8/68
7/9/68	7/9/68
7/10/68	7/10/68
7/11/68	7/11/68
7/12/68	7/12/68
7/13/68	7/13/68
7/14/68	7/14/68
7/15/68	7/15/68
7/16/68	7/16/68
7/17/68	7/17/68
7/18/68	7/18/68
7/19/68	7/19/68
7/20/68	7/20/68
7/21/68	7/21/68
7/22/68	7/22/68
7/23/68	7/23/68
7/24/68	7/24/68
7/25/68	7/25/68
7/26/68	7/26/68
7/27/68	7/27/68
7/28/68	7/28/68
7/29/68	7/29/68
7/30/68	7/30/68
7/31/68	7/31/68
8/1/68	8/1/68
8/2/68	8/2/68
8/3/68	8/3/68
8/4/68	8/4/68
8/5/68	8/5/68
8/6/68	8/6/68
8/7/68	8/7/68
8/8/68	8/8/68
8/9/68	8/9/68
8/10/68	8/10/68
8/11/68	8/11/68
8/12/68	8/12/68
8/13/68	8/13/68
8/14/68	8/14/68
8/15/68	8/15/68
8/16/68	8/16/68
8/17/68	8/17/68
8/18/68	8/18/68
8/19/68	8/19/68
8/20/68	8/20/68
8/21/68	8/21/68
8/22/68	8/22/68
8/23/68	8/23/68
8/24/68	8/24/68
8/25/68	8/25/68
8/26/68	8/26/68
8/27/68	8/27/68
8/28/68	8/28/68
8/29/68	8/29/68
8/30/68	8/30/68
8/31/68	8/31/68
9/1/68	9/1/68
9/2/68	9/2/68
9/3/68	9/3/68
9/4/68	9/4/68
9/5/68	9/5/68
9/6/68	9/6/68
9/7/68	9/7/68
9/8/68	9/8/68
9/9/68	9/9/68
9/10/68	9/10/68
9/11/68	9/11/68
9/12/68	9/12/68
9/13/68	9/13/68
9/14/68	9/14/68
9/15/68	9/15/68
9/16/68	9/16/68
9/17/68	9/17/68
9/18/68	9/18/68
9/19/68	9/19/68
9/20/68	9/20/68
9/21/68	9/21/68
9/22/68	9/22/68
9/23/68	9/23/68
9/24/68	9/24/68
9/25/68	9/25/68
9/26/68	9/26/68
9/27/68	9/27/68
9/28/68	9/28/68
9/29/68	9/29/68
9/30/68	9/30/68
10/1/68	10/1/68
10/2/68	10/2/68
10/3/68	10/3/68
10/4/68	10/4/68
10/5/68	10/5/68
10/6/68	10/6/68
10/7/68	10/7/68
10/8/68	10/8/68
10/9/68	10/9/68
10/10/68	10/10/68
10/11/68	10/11/68
10/12/68	10/12/68
10/13/68	10/13/68
10/14/68	10/14/68
10/15/68	10/15/68
10/16/68	10/16/68
10/17/68	10/17/68
10/18/68	10/18/68
10/19/68	10/19/68
10/20/68	10/20/68
10/21/68	10/21/68
10/22/68	10/22/68
10/23/68	10/23/68
10/24/68	10/24/68
10/25/68	10/25/68
10/26/68	10/26/68
10/27/68	10/27/68
10/28/68	10/28/68
10/29/68	10/29/68
10/30/68	10/30/68
10/31/68	10/31/68
11/1/68	11/1/68
11/2/68	11/2/68
11/3/68	11/3/68
11/4/68	11/4/68
11/5/68	11/5/68
11/6/68	11/6/68
11/7/68	11/7/68
11/8/68	11/8/68
11/9/68	11/9/68
11/10/68	11/10/68
11/11/68	11/11/68
11/12/68	11/12/68
11/13/68	11/13/68
11/14/68	11/14/68
11/15/68	11/15/68
11/16/68	11/16/68
11/17/68	11/17/68
11/18/68	11/18/68
11/19/68	11/19/68
11/20/68	11/20/68
11/21/68	11/21/68
11/22/68	11/22/68
11/23/68	11/23/68
11/24/68	11/24/68
11/25/68	11/25/68
11/26/68	11/26/68
11/27/68	11/27/68
11/28/68	11/28/68
11/29/68	11/29/68
11/30/68	11/30/68
12/1/68	12/1/68
12/2/68	12/2/68
12/3/68	12/3/68
12/4/68	12/4/68
12/5/68	12/5/68
12/6/68	12/6/68
12/7/68	12/7/68
12/8/68	12/8/68
12/9/68	12/9/68
12/10/68	12/10/68
12/11/68	12/11/68
12/12/68	12/12/68
12/13/68	12/13/68
12/14/68	12/14/68
12/15/68	12/15/68
12/16/68	12/16/68
12/17/68	12/17/68
12/18/68	12/18/68
12/19/68	12/19/68
12/20/68	12/20/68
12/21/68	12/21/68
12/22/68	12/22/68
12/23/68	12/23/68
12/24/68	12/24/68
12/25/68	12/25/68
12/26/68	12/26/68
12/27/68	12/27/68
12/28/68	12/28/68
12/29/68	12/29/68
12/30/68	12/30/68
12/31/68	12/31/68

July 9, 1944.

Observer: Walter H. Good

Recorder: Ditto

Time : Ditto

Instrument:

Gurley No. 38103.

Field Record.

Final field notes.

July 9, 1944: Cr. E. E.
 of Polaris, lat. 40° 0h 41.2m a.m.
 Red. to long. $113^{\circ} 35' W.$ - 01.25
 Red. to lat. $42^{\circ} 25' N.$ + 0.35

L.M.T. of E.E. of Polaris 0h 40.3m a.m.
 Watch fast of L.M.T. 34.7

Watch time of E.E. 1h 15.0m a.m.

Telescope.

Watch Time.

Direct-----1h 12m 08s
 Reversed-----1h 14m 12s
 Reversed-----1h 15m 36s
 Direct-----1h 17m 00s

Mean-----1h 14m.44s a.m.

Declination of Polaris $88^{\circ} 59' 38.4s$

Logcos $88^{\circ} 59' 38.4'' = 8.244453$
 " $42^{\circ} 25' = 9.868209$

Logsin A -----
 A = $1^{\circ} 21' 46'' = 8.376244$

MEMO:

Reduction formulas used above-

$$\sin A = \frac{\cos \delta}{\cos \theta}$$

July 9, 1944, at the corner of Tps.
 11 and 12 S., Rs. 24 and 25 E.,
 Boise Meridian, in lat. $42^{\circ} 25' N.$,
 long. $113^{\circ} 35' W.$, at 0h 40.3m.,
 a.m., l.m.t., I observe Polaris at
 eastern elongation, making four
 observations, two each with the
 telescope in direct and reversed
 positions, and mark the mean point
 in the line thus determined, on a
 peg driven firmly in the ground,
 8.00 chs. N.

Azimuth of Polaris at eastern
 elongation = $1^{\circ} 21' 46''$.

July 10: I lay off the azimuth of
 Polaris, $1^{\circ} 21' 46''$, to the west,
 and mark the meridian thus determined
 by a tack in a peg driven firmly in
 the ground, 8.00 chs. N.

H - 4

Sept. 4, 1944.

William H. Teller, observer;
Donald Skinner, recording.Buff No. 18001
General Land Office
solar transit.

Polaris at elongation, observing program "b".

Field Record			Final Field Notes
Sept. 4, 1944, Gr. E. E. of Polaris, lat. 40°	= 8h 54'.2 p.m.		Sept. 4, 1944, at a point near the SE. cor. of T. 41 N., R. 5 E., N. M. P. M., in Colorado, in latitude 37° 45' N., longitude 106° 22' W., at 8h 57'.7m, M. W. T., I observe Polaris at E. elongation, making four observations, two each with the telescope in direct and re- versed positions, reading the deflection angle to a point on cliffe eight chains N. of my station, east to Polaris; azimuth of Polaris at eastern elong. = 1° 16' 08" Mean deflection angle = 1° 16' 00" True bearing of mark = N. 0° 00' 08" E.
Red. to long. 106° 22' W.	= - 1'.3		
Red. to lat. 37° 45' N.	= 0'.2		
L. M. T. of E. E. of Polaris	8h 53.1 p.m.		
Watch fast of L. M. T.	5.3		
Watch time of E. E. of Polaris	8h 58'.4 p.m.		
Telescope	Watch Time	Deflection angle	
Direct	8h 56m 38s	1° 16' 00"	
Reversed	8h 57m 28s	1° 16' 00"	
Direct	8h 57m 43s	1° 16' 00"	
Reversed	8h 58m 56s	1° 16' 00"	
Mean	8h 57m 41s	1° 16' 00"	
Declination of Polaris = 88° 59' 48" N.			
Latitude	Declination		
	88° 59' 40"	88° 59' 48"	88° 59' 50"
37° 00'	1° 15' 33"	1° 15' 23"	1° 15' 20"
37° 45'		1° 16' 08"	
38° 00'	1° 16' 34"	1° 16' 24"	1° 16' 21"

The sun at meridian passage, for time.

Sept. 4:	Watch time, sun's west limb	12 ^h 03 ^m 10 ^s
	" " " east "	12 05 15
	Watch time of apparent noon	12 ^h 04 ^m 12 ^s
	Apparent noon	12 ^h 00 ^m 00 ^s
	Equation of time	- 1 07 L.M.T. 11 58 53
	Watch fast of local mean time	5 ^m 19 ^s

1. The first part of the report is a general introduction to the subject of the study. It discusses the importance of the study and the objectives of the research.

2. The second part of the report is a detailed description of the methodology used in the study. It includes information about the sample size, the data collection methods, and the statistical analysis techniques.

3. The third part of the report is a presentation of the results of the study. It includes tables and figures that show the data collected and the statistical analysis results.

4. The fourth part of the report is a discussion of the results of the study. It discusses the implications of the findings and the limitations of the study.

5. The fifth part of the report is a conclusion. It summarizes the main findings of the study and provides recommendations for future research.

6. The sixth part of the report is a list of references. It includes all the sources of information used in the study.

7. The seventh part of the report is an appendix. It includes any additional information that is relevant to the study.

8. The eighth part of the report is a glossary. It defines the key terms used in the study.

9. The ninth part of the report is a list of abbreviations. It includes all the abbreviations used in the study.

10. The tenth part of the report is a list of figures. It includes all the figures used in the study.

11. The eleventh part of the report is a list of tables. It includes all the tables used in the study.

12. The twelfth part of the report is a list of equations. It includes all the equations used in the study.

13. The thirteenth part of the report is a list of symbols. It includes all the symbols used in the study.

14. The fourteenth part of the report is a list of footnotes. It includes all the footnotes used in the study.

15. The fifteenth part of the report is a list of appendices. It includes all the appendices used in the study.

16. The sixteenth part of the report is a list of references. It includes all the references used in the study.

17. The seventeenth part of the report is a list of abbreviations. It includes all the abbreviations used in the study.

18. The eighteenth part of the report is a list of figures. It includes all the figures used in the study.

19. The nineteenth part of the report is a list of tables. It includes all the tables used in the study.

20. The twentieth part of the report is a list of equations. It includes all the equations used in the study.

21. The twenty-first part of the report is a list of symbols. It includes all the symbols used in the study.

22. The twenty-second part of the report is a list of footnotes. It includes all the footnotes used in the study.

23. The twenty-third part of the report is a list of appendices. It includes all the appendices used in the study.

24. The twenty-fourth part of the report is a list of references. It includes all the references used in the study.

25. The twenty-fifth part of the report is a list of abbreviations. It includes all the abbreviations used in the study.

26. The twenty-sixth part of the report is a list of figures. It includes all the figures used in the study.

27. The twenty-seventh part of the report is a list of tables. It includes all the tables used in the study.

28. The twenty-eighth part of the report is a list of equations. It includes all the equations used in the study.

29. The twenty-ninth part of the report is a list of symbols. It includes all the symbols used in the study.

30. The thirtieth part of the report is a list of footnotes. It includes all the footnotes used in the study.

31. The thirty-first part of the report is a list of appendices. It includes all the appendices used in the study.

32. The thirty-second part of the report is a list of references. It includes all the references used in the study.

33. The thirty-third part of the report is a list of abbreviations. It includes all the abbreviations used in the study.

34. The thirty-fourth part of the report is a list of figures. It includes all the figures used in the study.

35. The thirty-fifth part of the report is a list of tables. It includes all the tables used in the study.

36. The thirty-sixth part of the report is a list of equations. It includes all the equations used in the study.

37. The thirty-seventh part of the report is a list of symbols. It includes all the symbols used in the study.

38. The thirty-eighth part of the report is a list of footnotes. It includes all the footnotes used in the study.

39. The thirty-ninth part of the report is a list of appendices. It includes all the appendices used in the study.

40. The fortieth part of the report is a list of references. It includes all the references used in the study.

41. The forty-first part of the report is a list of abbreviations. It includes all the abbreviations used in the study.

42. The forty-second part of the report is a list of figures. It includes all the figures used in the study.

43. The forty-third part of the report is a list of tables. It includes all the tables used in the study.

44. The forty-fourth part of the report is a list of equations. It includes all the equations used in the study.

45. The forty-fifth part of the report is a list of symbols. It includes all the symbols used in the study.

46. The forty-sixth part of the report is a list of footnotes. It includes all the footnotes used in the study.

47. The forty-seventh part of the report is a list of appendices. It includes all the appendices used in the study.

48. The forty-eighth part of the report is a list of references. It includes all the references used in the study.

49. The forty-ninth part of the report is a list of abbreviations. It includes all the abbreviations used in the study.

50. The fiftieth part of the report is a list of figures. It includes all the figures used in the study.

N - S

Observer Thomas W. Crawford
Transit Buff No. 10899.

September 10, 1944, at a transit point, near the north east corner of T. 38 N., R. 7 E., New Mexico Principal Meridian, Colorado, in latitude $37^{\circ} 34.5' N.$, and longitude $106^{\circ} 8.4' W.$, at 8h 27.3m p.m., L. M. T., I observe Polaris at eastern elongation, making four observations, two each with the telescope in direct and reversed positions, reading the deflection angle from a light bulb, in a street light, about 20 chs. N., east to Polaris:

Azimuth of Polaris at eastern elongation $1^{\circ} 15' 55''$
 Mean deflection angle $2^{\circ} 02' 22''$
 True bearing to street light $N. 0^{\circ} 46' 27'' W.$

Sept. 10, 1944, Gr. E. E.
 of Polaris lat. 40°
 Rad. to long. $106^{\circ} 8.4' W.$
 Red. to lat. $37^{\circ} 34.5' N.$
 L. M. T. of E. E. Polaris
 Watch fast of L. M. T.
 Watch time of E. E.

8h 30m 42s p.m.
 - 1 10s
 - 15s
 8h 29m 17s p.m.
 4m 32s
 8h 33m 49s p.m.

Telescope	Watch time	Deflection angle
Direct -----	8h 27m 30s	$2^{\circ} 01' 30''$
Reversed -----	8 30 00	$2^{\circ} 03' 00''$
Reversed -----	8 32 42	$2^{\circ} 02' 00''$
Direct -----	8 36 10	$2^{\circ} 03' 00''$
Mean -----	8h 31m 37s	$2^{\circ} 02' 22''$

Declination of Polaris $88^{\circ} 59' 49.7''$

	$88^{\circ} 59' 40''$	$88^{\circ} 59' 49.7''$	$88^{\circ} 59' 50''$
	Azimuth		
Latitude			
$37^{\circ} 00'$	$1^{\circ} 15' 33''$	$1^{\circ} 15' 20.4''$	$1^{\circ} 15' 20''$
$37^{\circ} 34.5'$		$1^{\circ} 15' 55''$	
$38^{\circ} 00'$	$1^{\circ} 16' 34''$	$1^{\circ} 15' 21.4''$	$1^{\circ} 16' 21''$

Azimuth of Polaris at elongation computed
 by the equation

$$\sin A = \frac{\cos d}{\cos \phi}$$

$$\begin{array}{rcl} \log \cos d & 8.2430599 & \\ + \cos \phi & 9.8990298 & \\ \hline \sin A & 9.3440301 & 1^{\circ} 15' 55'' \end{array}$$

H - 6

Example of observation of Polaris at elongation for azimuth, observing program "C".

Field record.				Transcribed field notes.
<div>May 31, 1944, Gr.m.t., E.E. of Polaris, lat. 40° $3^h 13.8^m$ a.m. Red. to long. $104^{\circ}17'05.5''$W. - 1.1 Red. to lat. $33^{\circ}23'40.8''$N. - 0.7 L.m.t. of E.E. of Polaris $3^h 12.0^m$ a.m.</div>				<div>May 31, 1944, at the closing Tp. cor., on the 2nd Standard Parallel South, in latitude $33^{\circ}23'40.8''$ N., and longitude $104^{\circ}17'05.5''$ W., as computed from tie to U. S. Coast and Geodetic Survey station "Comanche" in sec. 36, T. 10 S., R. 26 E., in order to verify the alignment of the east bdy. of T. 11 S., R. 26 E., I bisect Polaris, follow the motion of the star to eastern elongation, at $3^h 12^m$ a.m., l.m.t., and mark the direction upon a peg driven firmly in the ground 8 obs. N.; I then reverse the instrument, again bisect Polaris, and mark the direction upon the peg. Without changing the instrument in horizontal motion, I sight to Polaris to make certain that the settings were made at elongation; there appeared to be no deviation in azimuth for some 15 or 20 minutes.</div>
Declination of Polaris = $88^{\circ}59'41.5''$				
	Declination			
Latitude	$88^{\circ}59'40''$	$88^{\circ}59'41.5''$	$88^{\circ}59'50''$	
	Azimuth			
$33^{\circ}00'00''$	$1^{\circ}11'56''$		$1^{\circ}11'44''$	
$33^{\circ}23'40.8''$	$1^{\circ}12'14''$	$1^{\circ}12'04''$		
$34^{\circ}00'00''$	$1^{\circ}12'47''$	$1^{\circ}12'34''$		
<div>I lay off the azimuth of Polaris, $1^{\circ}12'14''$, to the west of the mean direction determined by the observation and set a point for the test meridian; then by direct and reversed sights, I ascertain that the angle subtended by the flag on the cor. of secs. 1, 6, 7, and 12, is $0^{\circ}13'08''$, or $0^{\circ}00'08''$ from the reported bearing.</div>				

THE UNIVERSITY OF CHICAGO PRESS

NAME	ADDRESS
J. H.
...	...
...	...
...	...
...	...
...	...
...	...
...	...
...	...

...

...

1 - 2

Hour Angle Observation of Polaris in Daylight with Verification of Watch Time by Noon Observation of Sun.

Date September 4, 1944 Observer Norman D. Price Instrument Buff No. 17998

At camp in sec. 5, T. 25 S., R. 3 W., Willamette Mer., Oregon, in lat. $43^{\circ} 25' 30''$ N., and long. $123^{\circ} 04' 25''$ W., to check the reading of my watch which indicates approximate standard time for the 120th meridian, I make a meridian observation of the sun for apparent noon as follows:

Watch time of sun's transit-----12h 10m 36s p.m.
Watch fast of l.m.t.-----11m 44s
Same by calculated diff. in long.-12m 18s
Watch slow-----34s

At the same station, with my watch re-set to indicate correct 120th mer. time, I make an hour angle observation of Polaris east of the meridian, making four observations, two each with the telescope in direct and reversed positions and mark the mean point in the line thus determined, on a peg driven firmly in the ground, 10 chs. northerly from my station, as follows:

Telescope	Watch Time
Direct	6h 28m 15s p.m.
Reversed	6 31 15
Reversed	6 32 25
Direct	6 34 50

Mean-----6h 31m 41s p.m.
Watch fast of l.m.t.-----12m 18s
L.M.T. of obsn.-----6h 19m 23s p.m.

Nearest u.c. of Polaris, civil date and mean time, is

2h 49m 54s a.m., September 5, 1944
Sub. 1m 20s Reduction to longitude of this station
2h 48m 34s a.m., l.m.t., u.c. of Polaris
12h 00m 00s Add
14h 48m 34s
6h 19m 23s Subtract l.m.t. of observation
8h 29m 11s Mean time hour angle of Polaris
1m 24s Add for reduction to sidereal time
8h 30m 35s Sidereal time hour angle of Polaris
127° 38' 45" Sidereal time hour angle of Polaris

Tan A = $\frac{\sin T}{\cos \phi \tan D - \sin \phi \cos T}$ Formula for reduction of Azimuth "A"

T = Sidereal hour angle 127° 38' 45"
φ = Latitude of station 43° 25' 30"
D = Decl. of Polaris 88° 59' 48"

Log cos φ 9.861101	Log sin φ 9.837213
Log tan D 11.756633	Log cos T 9.785884
Add-----1.617734	Add-----9.623097
Anti-log-41.470	Anti-log--0.41985
Anti-log-0.41985 Add	Algebraic sign is minus
Anti-log-41.88965 of denominator	since cos T is in 2d
Log-1.622110 of denominator	quadrant.
Numerator-----	Log sin T 9.898617
Subtract log. of denominator-----	1.622110
Log. tan A-----	8.276507
Azimuth of Polaris "A"-----	1° 04' 58"

I lay off the azimuth of Polaris 1° 05', to the west, and mark the meridian thus determined, by a tack in a peg driven firmly in the ground, 10 chs. N. of my station.

The following information was obtained from the records of the
 Department of the Interior, Bureau of Land Management, at
 Washington, D. C., on the 10th day of May, 1964.
 The records show that the following land was owned by the
 United States Government on the 10th day of May, 1964:
 1. A certain tract of land, situated in the County of
 [County Name], State of [State Name], containing
 [Area] acres, more or less, and being more particularly
 described as follows: [Description of land]
 2. A certain tract of land, situated in the County of
 [County Name], State of [State Name], containing
 [Area] acres, more or less, and being more particularly
 described as follows: [Description of land]
 3. A certain tract of land, situated in the County of
 [County Name], State of [State Name], containing
 [Area] acres, more or less, and being more particularly
 described as follows: [Description of land]
 4. A certain tract of land, situated in the County of
 [County Name], State of [State Name], containing
 [Area] acres, more or less, and being more particularly
 described as follows: [Description of land]
 5. A certain tract of land, situated in the County of
 [County Name], State of [State Name], containing
 [Area] acres, more or less, and being more particularly
 described as follows: [Description of land]
 6. A certain tract of land, situated in the County of
 [County Name], State of [State Name], containing
 [Area] acres, more or less, and being more particularly
 described as follows: [Description of land]
 7. A certain tract of land, situated in the County of
 [County Name], State of [State Name], containing
 [Area] acres, more or less, and being more particularly
 described as follows: [Description of land]
 8. A certain tract of land, situated in the County of
 [County Name], State of [State Name], containing
 [Area] acres, more or less, and being more particularly
 described as follows: [Description of land]
 9. A certain tract of land, situated in the County of
 [County Name], State of [State Name], containing
 [Area] acres, more or less, and being more particularly
 described as follows: [Description of land]
 10. A certain tract of land, situated in the County of
 [County Name], State of [State Name], containing
 [Area] acres, more or less, and being more particularly
 described as follows: [Description of land]

Hour Angle Observation of Polaris, Observing Program "A."

Observer: Geo. F. Rigby

Recorder: LeRoy V. Wollney

Date: September 9, 1944.

Instrument: W. & L. E. Gurley No. 2350

Field Record				Final Field Notes
Meridian observation of the sun for apparent noon:				Sept. 9, 1944, in camp in the SE $\frac{1}{4}$ of sec. 15, T. 35 S., R. 25 E., Willamette Meridian, Oregon, in latitude 42° 32' 24" N., and longitude 119° 45' 30" W., I make a meridian observation of the sun for apparent noon.
$\phi = 42^{\circ} 32' 24''$ N.		90° 00' 00"		
$d = 5^{\circ} 08' 28''$ N.		37 23 56		
$\phi - d = 37^{\circ} 23' 56''$		$v = 52^{\circ} 36' 04''$		
		Watch time		
Sun's W. limb		12h 54m 48s		Watch time of obsn. = 12h 55m 52s
" E. "		12 56 56		
Watch time of app. noon		12h 55m 52s		Watch fast of l.m.t. = 58m 42s
App. noon 12h 00m 00s				
Equa. of time - 2 50				
L.M.T. of apparent noon		11 57 10		
Watch fast of l.m.t.		58h 42m		
Hour angle observation of Polaris:				
Telescope		Watch time		At the same station, at 7h 02.7m p.m., l.m.t., I make an hour angle observation on Polaris east of the meridian, making four observa- tions, two each with the telescope in direct and reversed positions, and mark the mean point in the line thus deter- mined, on a peg driven firmly in the ground, 10 chs. N.
Direct		7h 59m 32s p.m.		
Reversed		8 00 50		
Reversed		8 02 00		
Direct		8 03 20		
Mean		8h 01m 26s p.m.		
Watch fast of l.m.t.		- 58 42		
L.M.T. of obsn.		7h 02m 44s p.m.		
		7h 02.7m p.m.		
Gr. U.C. of Polaris, Sept. 10, 1944		2h 30.3m a.m.		
Red. to long. 119° 45' 30" W.		- 1.3		
L.M.T., U.C. of Polaris, Sept. 10		2h 29.0m a.m.		
L.M.T. of obsn. Sept. 9		7 02.7 p.m.		
Hour angle of Polaris east of meridian		7h 26.3m		
Declination of Polaris 88° 59' 50"				
Mean time hour angle	Azimuth of Polaris			Sept. 10, I lay off the azimuth of Polaris, 1° 15' 18", to the west, and mark the meridian thus deter- mined, by a tack in a peg driven firmly in the ground, 8 chs. N.
	Mean declination		Correction additive for decli- nation	
	+89° 00' 00"			
	Latitude			
	42°	42° 32.4'	44°		88° 59' 50"
7h 18.8m	75.5'	76.1'	77.9'	0.2'
7 26.3	75.1	75.1	75.1	0.2'
7 28.8	74.1	74.8	76.6	0.2'
Azimuth of Polaris = 1° 15.1' + 0.2' = 1° 15' 18"				

The first part of the report is devoted to a description of the
 methods used in the investigation. The second part contains the
 results of the experiments. The third part is a discussion of the
 results. The fourth part is a conclusion. The fifth part is a
 list of references. The sixth part is a list of figures. The
 seventh part is a list of tables. The eighth part is a list of
 appendices. The ninth part is a list of footnotes. The tenth
 part is a list of errata. The eleventh part is a list of
 acknowledgments. The twelfth part is a list of dedications.
 The thirteenth part is a list of prefaces. The fourteenth
 part is a list of afterwords. The fifteenth part is a list of
 indexes. The sixteenth part is a list of glossaries. The
 seventeenth part is a list of abbreviations. The eighteenth
 part is a list of symbols. The nineteenth part is a list of
 units. The twentieth part is a list of constants. The twenty-
 first part is a list of formulas. The twenty-second part is a
 list of diagrams. The twenty-third part is a list of maps. The
 twenty-fourth part is a list of photographs. The twenty-fifth
 part is a list of tables. The twenty-sixth part is a list of
 figures. The twenty-seventh part is a list of tables. The
 twenty-eighth part is a list of figures. The twenty-ninth
 part is a list of tables. The thirtieth part is a list of
 figures. The thirty-first part is a list of tables. The thirty-
 second part is a list of figures. The thirty-third part is a
 list of tables. The thirty-fourth part is a list of figures.
 The thirty-fifth part is a list of tables. The thirty-sixth
 part is a list of figures. The thirty-seventh part is a list
 of tables. The thirty-eighth part is a list of figures. The
 thirty-ninth part is a list of tables. The fortieth part is
 a list of figures. The forty-first part is a list of tables.
 The forty-second part is a list of figures. The forty-third
 part is a list of tables. The forty-fourth part is a list of
 figures. The forty-fifth part is a list of tables. The forty-
 sixth part is a list of figures. The forty-seventh part is a
 list of tables. The forty-eighth part is a list of figures.
 The forty-ninth part is a list of tables. The fiftieth part
 is a list of figures. The fifty-first part is a list of tables.
 The fifty-second part is a list of figures. The fifty-third
 part is a list of tables. The fifty-fourth part is a list of
 figures. The fifty-fifth part is a list of tables. The fifty-
 sixth part is a list of figures. The fifty-seventh part is a
 list of tables. The fifty-eighth part is a list of figures.
 The fifty-ninth part is a list of tables. The sixtieth part
 is a list of figures. The sixty-first part is a list of tables.
 The sixty-second part is a list of figures. The sixty-third
 part is a list of tables. The sixty-fourth part is a list of
 figures. The sixty-fifth part is a list of tables. The sixty-
 sixth part is a list of figures. The sixty-seventh part is a
 list of tables. The sixty-eighth part is a list of figures.
 The sixty-ninth part is a list of tables. The seventieth part
 is a list of figures. The seventy-first part is a list of tables.
 The seventy-second part is a list of figures. The seventy-third
 part is a list of tables. The seventy-fourth part is a list of
 figures. The seventy-fifth part is a list of tables. The seven-
 ty-sixth part is a list of figures. The seventy-seventh part
 is a list of tables. The seventy-eighth part is a list of
 figures. The seventy-ninth part is a list of tables. The eight-
 yeth part is a list of figures. The eighty-first part is a list
 of tables. The eighty-second part is a list of figures. The
 eighty-third part is a list of tables. The eighty-fourth part
 is a list of figures. The eighty-fifth part is a list of tables.
 The eighty-sixth part is a list of figures. The eighty-seventh
 part is a list of tables. The eighty-eighth part is a list of
 figures. The eighty-ninth part is a list of tables. The ninety-
 th part is a list of figures. The ninety-first part is a list
 of tables. The ninety-second part is a list of figures. The
 ninety-third part is a list of tables. The ninety-fourth part
 is a list of figures. The ninety-fifth part is a list of tables.
 The ninety-sixth part is a list of figures. The ninety-seventh
 part is a list of tables. The ninety-eighth part is a list of
 figures. The ninety-ninth part is a list of tables. The hundred
 part is a list of figures.

1 - 4

Date: May 17, 1943. Observer: Hal D. Craig Instrument,
Recorder: M. S. Craig Buff No. 9985.

HOOR ANGLE OBSERVATION OF POLARIS, OBSERVING PROGRAM "b"

Field record.				Final field notes.
Hour angle observation of Polaris				May 17, 1943:
Telescope	Horizontal angle; Polaris to Flag	Watch time, P.M.		At my Station in the Village of Alvin, Wis., approximately 20 chs. north of the south boundary of section 35, T. 41 N., R. 13 E., 4th Prin. Mer., Wis., in longitude 88° 50' W., and latitude 45° 59' N., having corrected my watch to the true 90th meridian standard time; at 7h 45m 25s l.m.t., I make an hour angle observation on Polaris west of the meridian, two each with the telescope in direct and reversed positions, reading the horizontal angle from a narrow strip of flag cloth placed vertically on a tree about 7.00 chs. dist., which an earlier solar observation shows to have a bearing of N. 0° 23' W.; to Polaris, at the left of the reference flag.
Direct	0° 28' 00"	7h 38m 00s		
Reversed	0° 26' 00"	7h 40m 00s		
Reversed	0° 25' 00"	7h 41m 00s		
Direct	0° 27' 00"	7h 42m 00s		
Mean	0° 26' 30"	7h 40m 15s		
Watch corrected to 90th meridian standard time.				
Correction for longitude				4m 40s
L.M.T. of observation, May 17, 1943				7h 44m 55s
Gr. U.C. of Polaris, same date, 10h 6m 54s, a.m.				
Reduced to longitude 88° 50' W., ----				Om 58s
Hour angle of Polaris, west of meridian				9h 38m 59s
Declination of Polaris				88° 59' 26.8"
Azimuth of Polaris		Correction additive for Declination		
Mean declination 88° 59' 45"		88° 59' 26.8"		
Latitude				
Mean time	44°	45° 59'	46°	
hour angle				
9h 38.4m	47.4'	49.0'	49.0'	00.2'
9h 39.0m		48.8'		00.2'
9h 40.4m	44.4'	45.9'	45.9'	00.2'
Azimuth of Polaris, 0° 48' 48" + 00.2'				
0° 49' 00"				
				Watch time of observation, 7h 40m 15s. p.m.
				Mean horizontal angle from Polaris to flag, 0° 26' 30"
				Azimuth of Polaris west of meridian, 0° 49' 00"
				True bearing of flag, N. 0° 22' 30"W.

Example of Hour Angle Observation of Polaris for Azimuth

Observer: Carl S. Swannholm

Instrument: Buff and Buff No. 17994

September 23, 1944

Station: A point on the Navy power line near the Hawthorneterminus in section 27, T. 8 N., R. 30 E., Mount Diablo Meridian, Nevada.

Latitude: $38^{\circ}31' N.$ Longitude: $118^{\circ}38' W.$, ($115^{\circ} = 7h40m$
 $3^{\circ} = 12m$
 $38' = 2m32s$
 $7h34m32s$)

Long. correction, additive
 to Pacific standard time $5m28s$

Hour angle observation on Polaris, east of the meridian: Reference to center of water tower about 3 miles distant, and west of Polaris.

Telescope	Horizontal angle from tower to Polaris	Watch time
Direct	$26^{\circ}25'00''$	$7h34m30s$ p.m.
Reversed	$26^{\circ}25'30''$	$7\ 28\ 30$
Reversed	$26^{\circ}26'00''$	$7\ 33\ 30$
Direct	$26^{\circ}26'30''$	$7\ 38\ 00$
Mean	$26^{\circ}25'45''$	$7\ 31\ 15$ p.m.
Watch fast of Pacific std. time		$- 1h03m08s$
Longitude correction		$+ 5m28s$
L. M. T. of observation		$6h33m43s$ p.m. $6h33.7m$ p.m.
Greenwich U. C. of Polaris, September 24th- - - - -		$1h35.4m$ a.m.
Correction for longitude		$- 1.3m$
L. M. T. of U. C. - - - - -		$1h34.1m$ a.m.
		$+12h$
L. M. T. of observation- - - - -		$1h34.1m$
Hour angle of Polaris, east of the meridian		$6h33.7m$ $7h00.4m$
Declination of Polaris, September 23, 1944- - - - -		$88^{\circ}59'54.0''$

Azimuth of Polaris

Mean time hour angle	Mean declination	Correction to azimuth
	$89^{\circ}00'00''$	Additive for declination $88^{\circ}59'54''$
	Latitude	
	$38^{\circ}00'$ $38^{\circ}31'$ $40^{\circ}00'$	
$6h58.9m$	$73.3'$ $73.8'$ $75.4'$	
$7h00.4m$	$73.6'$	$0.1'$
$7h08.6m$	$72.3'$ $72.8'$ $74.4'$	
Azimuth of Polaris, declination $89^{\circ}00'00''$		$73.6'$
Correction to declination $88^{\circ}59'54.0''$		$+ 0.1'$
		$73.7'$
Azimuth of Polaris- - - - -		N. $1^{\circ}13'42''$ E.
Horizontal angle to west of star		$26^{\circ}25'45''$
True bearing of reference point- - - - -		N. $25^{\circ}12'03''$ W.

Financial Statement for the Year Ended December 31, 1967

Assets

Current Assets

Accounts Receivable

Inventory

Prepaid Expenses

Other Current Assets

Total Current Assets

Fixed Assets

Property, Plant, and Equipment

Accumulated Depreciation

Total Fixed Assets

Total Assets

Liabilities and Equity

Current Liabilities

Accounts Payable

Notes Payable

Other Current Liabilities

Total Current Liabilities

Long-Term Liabilities

Bonds Payable

Mortgage Payable

Other Long-Term Liabilities

Total Long-Term Liabilities

Total Liabilities

Equity

Common Stock

Retained Earnings

Total Equity

Total Liabilities and Equity

Income Statement

Revenue

Cost of Goods Sold

Gross Profit

Operating Expenses

Operating Income

Other Income

Other Expenses

Net Income

Statement of Cash Flows

Cash

Accounts Receivable

Inventory

Prepaid Expenses

Other Current Assets

Accounts Payable

Notes Payable

Other Current Liabilities

Capital Contributions

Dividends Paid

Net Change in Cash

Cash at End of Year

Notes to Financial Statements

1. Description of the Company

2. Accounting Policies

3. Depreciation Method

4. Inventory Valuation

5. Accounts Receivable

6. Accounts Payable

7. Long-Term Liabilities

8. Equity

9. Income Tax

10. Other

Supplemental Information

1. Schedule of Assets and Liabilities

2. Schedule of Income

3. Schedule of Cash Flows

4. Schedule of Equity

5. Schedule of Other

Financial Statement for the Year Ended December 31, 1968

Assets

Current Assets

Accounts Receivable

Inventory

Prepaid Expenses

Other Current Assets

Total Current Assets

Fixed Assets

Property, Plant, and Equipment

Accumulated Depreciation

Total Fixed Assets

Total Assets

Liabilities and Equity

Current Liabilities

Accounts Payable

Notes Payable

Other Current Liabilities

Total Current Liabilities

Long-Term Liabilities

Bonds Payable

Mortgage Payable

Other Long-Term Liabilities

Total Long-Term Liabilities

Total Liabilities

Equity

Common Stock

Retained Earnings

Total Equity

Total Liabilities and Equity

Income Statement

Revenue

Cost of Goods Sold

Gross Profit

Operating Expenses

Operating Income

Other Income

Other Expenses

Net Income

Statement of Cash Flows

Cash

Accounts Receivable

Inventory

Prepaid Expenses

Other Current Assets

Accounts Payable

Notes Payable

Other Current Liabilities

Capital Contributions

Dividends Paid

Net Change in Cash

Cash at End of Year

Notes to Financial Statements

1. Description of the Company

2. Accounting Policies

3. Depreciation Method

4. Inventory Valuation

5. Accounts Receivable

6. Accounts Payable

7. Long-Term Liabilities

8. Equity

9. Income Tax

10. Other

Supplemental Information

1. Schedule of Assets and Liabilities

2. Schedule of Income

3. Schedule of Cash Flows

4. Schedule of Equity

5. Schedule of Other

Financial Statement for the Year Ended December 31, 1969

Assets

Current Assets

Accounts Receivable

Inventory

Prepaid Expenses

Other Current Assets

Total Current Assets

Fixed Assets

Property, Plant, and Equipment

Accumulated Depreciation

Total Fixed Assets

Total Assets

Liabilities and Equity

Current Liabilities

Accounts Payable

Notes Payable

Other Current Liabilities

Total Current Liabilities

Long-Term Liabilities

Bonds Payable

Mortgage Payable

Other Long-Term Liabilities

Total Long-Term Liabilities

Total Liabilities

Equity

Common Stock

Retained Earnings

Total Equity

Total Liabilities and Equity

Income Statement

Revenue

Cost of Goods Sold

Gross Profit

Operating Expenses

Operating Income

Other Income

Other Expenses

Net Income

Statement of Cash Flows

Cash

Accounts Receivable

Inventory

Prepaid Expenses

Other Current Assets

Accounts Payable

Notes Payable

Other Current Liabilities

Capital Contributions

Dividends Paid

Net Change in Cash

Cash at End of Year

Notes to Financial Statements

1. Description of the Company

2. Accounting Policies

3. Depreciation Method

4. Inventory Valuation

5. Accounts Receivable

6. Accounts Payable

7. Long-Term Liabilities

8. Equity

9. Income Tax

10. Other

Supplemental Information

1. Schedule of Assets and Liabilities

2. Schedule of Income

3. Schedule of Cash Flows

4. Schedule of Equity

5. Schedule of Other

Financial Statement for the Year Ended December 31, 1970

Assets

Current Assets

Accounts Receivable

Inventory

Prepaid Expenses

Other Current Assets

Total Current Assets

Fixed Assets

Property, Plant, and Equipment

Accumulated Depreciation

Total Fixed Assets

Total Assets

Liabilities and Equity

Current Liabilities

Accounts Payable

Notes Payable

Other Current Liabilities

Total Current Liabilities

Long-Term Liabilities

Bonds Payable

Mortgage Payable

Other Long-Term Liabilities

Total Long-Term Liabilities

Total Liabilities

Equity

Common Stock

Retained Earnings

Total Equity

Total Liabilities and Equity

Income Statement

Revenue

Cost of Goods Sold

Gross Profit

Operating Expenses

Operating Income

Other Income

Other Expenses

Net Income

Statement of Cash Flows

Cash

Accounts Receivable

Inventory

Prepaid Expenses

Other Current Assets

Accounts Payable

Notes Payable

Other Current Liabilities

Capital Contributions

Dividends Paid

Net Change in Cash

Cash at End of Year

Notes to Financial Statements

1. Description of the Company

2. Accounting Policies

3. Depreciation Method

4. Inventory Valuation

5. Accounts Receivable

6. Accounts Payable

7. Long-Term Liabilities

8. Equity

9. Income Tax

10. Other

Meridian observation of the sun for apparent noon:

September 24, 1944

Tangent to Sun's W. limb

Tangent to Sun's E. limb

Watch time of apparent noon

Watch time

12h4m35s p.m.

12 50 46 p.m.

12 49 41 p.m.

Apparent noon

11h59m60s

Equation of time

- 7 59

L.M.T. of apparent noon

11h52m01s a.m.

11 52 01 a.m.

05h57m40s

Watch fast L.M.T.

Long. correction + 5 28

Watch fast 120 Mer. S. time

150m08s

Hour angle observation on Polaris, west of the meridian; Reference to same point selected for observation of preceding evening.

Telescope	Horizontal angle from tower to Polaris	Watch time	
1st set:			
Direct	<u>23°59'15"</u>	7h09m20s a.m.	
Reversed	<u>23°59'30"</u>	7 13 00s a.m.	
Mean	23°59'22"		7h11m10s a.m.
2nd set:			
Direct	<u>23°58'45"</u>	7h17m00s a.m.	
Reversed	<u>23°58'30"</u>	7 19 00 a.m.	
Mean	23°58'38"		7h18m00s a.m.
3rd set:			
Direct	<u>23°58'15"</u>	7h21m00s a.m.	
Reversed	<u>23°58'30"</u>	7 23 00 a.m.	
Mean	23°58'22"		7h22m00s a.m.
Greenwich U.C. of Polaris, same date		1h35.4m a.m.	
Correction for longitude		- 1.3m	
L.M.T. of U.C.		1h34.1m a.m.	
	1st set	2nd set	3rd set
Watch time of obsn.	7h11m10s a.m.	7h18m00s a.m.	7h22m00s a.m.
Watch fast L.M.T.	57m40s	57m40s	57m40s
L.M.T. of obsn.	<u>6h13m30s a.m.</u>	<u>6h20m20s a.m.</u>	<u>6h24m20s a.m.</u>
	6h 13.5m a.m.	6h 20.3m a.m.	6h 24.3m a.m.
L.M.T. of U.C.	<u>1h 34.1m a.m.</u>	<u>1h 34.1m a.m.</u>	<u>1h 34.1m a.m.</u>
Hour angles, east-west	4h 39.4m	4h 46.2m	4h 50.2 m

Azimuth of Polaris

Mean time hour angle	Mean declination 89°00'00"	Correction to azimuth Additive for declination 88°59'54"
	Latitude 38°00' 38°31' 40°00'	
4h 39.2m	71.9'	72.4'
4h 39.4m		72.4'
4h 46.2m		73.1'
4h 49.2m	72.9'	73.4'
4h 50.2m		73.5'
4h 59.2m	73.8'	74.3'
Azimuth of Polaris, dec. 89°00'00"	72.4'	73.1'
Correction to dec. 88°59'54" (Additive)	0.1'	0.1'
	72.5'	73.2'
Azimuth of Polaris, dec. 89°59'54"	N. 1°12'30"W.	N. 1°13'18"W.
Hor. angle to west of star	23°59'22"	23°58'38"
True bearing of reference point	N. 23°11'52"W.	N. 23°11'50"W.
Mean true bearing of reference point	N. 25°11'53" W.	

Date: 5 Dec. 5, 1944 Observer: Hal D. Craig Instrument,
Recorder: M. S. Craig Buff No. 23461.

HOOR ANGLE OBSERVATION OF POLARIS, OBSERVING PROGRAM "b"

Field record				Final field notes	
Hour angle observation of Polaris					
Telescope	Horizontal angle from monument to Polaris		Watch time, p.m.		
Direct	124° 11' 30"		4h 47m 45s		
Reversed	124° 11' 30"		4h 49m 20s		
Reversed	124° 12' 00"		4h 51m 20s		
Direct	124° 12' 00"		4h 52m 30s		
Mean -- 124° 11' 45"			4h 50m 15s		
Watch corrected to 75th meridian standard time,			0m 0s		
Correction for longitude -----			-8m 8s		
L.M.T. of obs. Dec. 5, 1944,			4h 42m 07s		
Gr. U.C. of Polaris, same date -- 8h 48m 18s, p.m.					
Reduced to long.					
77° 01.6' -----		-51s	4h 47m 27s p.m.		
Hour angle of Polaris, east of meridian			<u>4h 5m 20s</u>		
Declination of Polaris,			<u>-89°00'20.4"</u>		
Azimuth of Polaris					
Mean declination 89° 00' 00"			Correction subtractive for declination, 89° 00' 20.4"		
Latitude					
Mean time	38°	38°53'	40°		
hour angles					
3h 59.3 m	66.4'	67.2'	68.3'	00.4'	
4h 05.3 m		68.2'		00.4'	
4h 09.3 m	68.0'	68.8'	69.9'	00.4'	
Azimuth of Polaris, 1° 08.2' -00.4'= <u>1° 07' 48"</u>					

December 5, 1944: from a point which is a cross in concrete walk across the street from the south entrance to the South Interior Building, Washington, D.C., I establish my station for observation about 2.00 obs. distant directly on line to the peak of the Washington Monument, in order to clear the vertical angle to Polaris; latitude 38° 53' 30" N., and longitude 77° 01' 36" W.; I correct my watch to the 75th meridian standard time, and at 4h 42m 7s., l.m.t., I make an hour angle observation on Polaris east of the meridian, two each with the telescope in direct and reversed positions, reading the horizontal angle from the peak of the Washington Monument, in the SE. quadrant, to Polaris, east of the meridian.
Mean watch time of obsn. 4h 50m 15s., p.m.
Mean horizontal angle, Polaris to monument, 124° 11' 45"
Azimuth of Polaris --- 1° 07' 48"
Angle from N. to Mon. 125° 19' 33"
True bearing of monument, S. 54° 40' 27" E.

Memo:

Accepted bearing of monument (weighted mean) = S. $54^{\circ} 40' 25''$ E.

1 - 7

Example of hour angle observation of Polaris, observing program "b":

Date: October 13, 1944.

Observer: Hugh B. Crawford

Instrument: Buff No. 17993

Field record.			Final field notes.
Hour angle observation on Polaris:			
Telescope.	Horizontal angle from post to Polaris.	Watch time.	
Direct ----	1° 13' 30"	6h 42m 42s	October 13, 1944, at a transit point, on a tract known as Outlet Lettered H, situated in the town of Waldo, Russell County, Kansas, in the W. ½ of SW. ¼, sec. 5, T. 11 S., R. 13 W., in latitude 39° 07' 24" N., and longitude 98° 47' 19" W., I find by comparison with a clock in the Union Pacific Depot that my watch is 10m 40s slow of 90th meridian standard war time.
Reversed ----		6 44 22	
Direct ----		6 45 22	
Reversed ----	4 54 40	6 46 12	
Mean	1° 13' 40"	6h 44m 39s	
Watch slow of 90th mer. standard war time		+10 40	At the same station at 5h 20m 07s p.m., l.m.t., I make an hour angle observation of Polaris, east of the meridian, two each with the telescope in direct and reversed positions, reading the horizontal deflection angle from the West edge of a stone post, 0.6 foot wide, 20.50 obs. N., E. to Polaris.
Correction for longitude		-35 12	
Correction for war time		-1 00 00	
L.M.T. of obsn. Oct. 13, 1944		5h 20m 07s p.m.	
Gr. U.C. of Polaris, Oct. 14, 1944		= 12h 17.0m a.m.	Watch time of obsn. = 6h 44m 39s p.m.
Red. to long. 98° 47' 19" W. ----		= - 1.1'	
L.M.T. U.C. ----		= 12h 15.9m a.m. -5 20.1	Mean horizontal angle from Polaris to W. edge of post = 1° 13' 40" W.
Hour angle of Polaris E. of the meridian	= 6h 55.8m		Azimuth of Polaris by inter. = 1 14 45
Declination of Polaris = 89° 00' 01"			Azimuth of Polaris by formula = 1 14 47
Mean time hour angle.	Azimuth of Polaris.		True bearing of W. edge of post N. 0° 01' 07" E.
	Mean declination 89° 00' 01"		
	Latitude		
	38°	39° 07' .4	40°
6h 48.9m	74' .1	75' .3	76' .2
55.8		74' .75	
58.9	73' .3	74' .5	75' .4
Azimuth of Polaris = 1° 14' 45"			by formula = 1° 14' 47"
by formula			

Comparison of meridian determined by direct altitude observation of the sun for azimuth, sun south declination:

Mean true bearing of E. edge of post = N. $0^{\circ} 03' 04''$ E.Deflection angle from E. edge of post to W. edge of post = - $0 \ 01 \ 35$ Mean true bearing of W. edge of post = N. $0^{\circ} 01' 29''$ E.Mean true bearing of W. edge of post by Polaris obsn. (using azimuth as reduced by formula) = N. $0^{\circ} 01' 07''$ E.

4 - 9

HOUR ANGLE OBSERVATION OF POLARIS FOR AZIMUTH AND LATITUDE.

Date: July 7, 1944. Observer: Ty White Instrument: Buff No. 16724

At Curley Sheep Guard Station on the Coconino National Forest, in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ of sec. 21, T. 24 N., R. 6 E., Gila and Salt River Mer., Arizona, in approximate latitude $35^{\circ} 26' N.$, and longitude $111^{\circ} 46' W.$, my watch reading correct standard time, as checked by radio time signals, make an hour angle observation of Polaris, east of the meridian, making four observations, two each with the telescope in direct and reversed positions, reading the horizontal angles in the direction N-E to Polaris from a well defined point on a dead pine, approximately 15 chains northwesterly.

To determine the latitude of the station, read the vertical angles to Polaris.

Mean horizontal angle from
reference point N-E to Polaris $1^{\circ} 31' 30''$
Mean observed vertical angle $34^{\circ} 29' 45''$
Mean watch time of observation 8h 07m 27s p.m.
Watch fast of l. m. t. 27m 04s
True bearing of reference point N. $1^{\circ} 12' 48'' W.$
Reduced latitude $35^{\circ} 26' 44'' N.$

Telescope	Horizontal angle	Vertical angle	Watch time
Direct	$1^{\circ} 31' 30''$	$34^{\circ} 31' 00''$	8h 03m 00s
Reversed	$1^{\circ} 29' 00''$	$34^{\circ} 28' 00''$	8 05 45
Reversed	$1^{\circ} 30' 30''$	$34^{\circ} 28' 30''$	8 08 50
Direct	$1^{\circ} 34' 00''$	$34^{\circ} 31' 30''$	8 12 12
Mean---	$1^{\circ} 31' 30''$	$34^{\circ} 29' 45''$	8h 07m 26.7s p.m.
Watch fast of local mean time			- 27m 00.0s
L. M. T. of observation, July 7, 1944			= 7h 40m 26.7s p.m.
Gr. U. C. of Polaris July 8			= 6h 40.8m a.m.
Reduced to longitude $111^{\circ} 46' W.$			= - 1.2
L. M. T. U. C. of Polaris July 8			= 6h 39.6m a.m.
			+12
L. M. T. of observation, July 7			= 7 40.4 p.m.
Hour angle of Polaris east of the meridian			= 10h 59.2m
Declination of Polaris			= $88^{\circ} 59' 38''$

Mean time hour angle	Primary adjustment additive, Polaris below the pole
	Declination
	$88^{\circ} 59' 40''$
10h 58.2m	$0^{\circ} 58' 19''$
10 59.2	$0^{\circ} 58' 23''$
11 10.2	$0^{\circ} 59' 02''$

Mean observed vertical angle, γ = $34^{\circ} 29' 45''$
Correction for refraction = $-1^{\circ} 24'$
h = $34^{\circ} 28' 21''$

Primary adjustment to elev.
of pole + $0^{\circ} 58' 23''$
Supplemental corr. = $0^{\circ} 00' 00''$
Latitude of station = $35^{\circ} 26' 44'' N.$
(See memorandum below)

Mean time hour angle	Azimuth of Polaris	Correction additive for declination
	Mean declination	$88^{\circ} 59' 40''$
	Latitude	$88^{\circ} 59' 40''$
	$34^{\circ} 35' 27'' 36''$	
10h 58.2m	$18^{\circ}.5$ $18^{\circ}.9$ $19^{\circ}.3$	$0^{\circ}.1$
10 59.2	$18^{\circ}.6$	
11 08.2	$15^{\circ}.5$ $15^{\circ}.8$ $15^{\circ}.9$	$0^{\circ}.1$

Mean horizontal angle from
Polaris to reference point = $1^{\circ} 31' 30''$

Azimuth of Polaris $18^{\circ}.6 + 0^{\circ}.1 = 0^{\circ} 18' 42'' E.$

True bearing of reference point = $N. 1^{\circ} 12' 48'' W.$

Memo:

Elevation of station / 7600 ft.; refraction coefficient = .77
Corrected latitude computation.

Mean observed vertical angle $34^{\circ} 29' 45''$
Refraction ($84'' \times .77 = 65''$) $- 1^{\circ} 05'$
Primary adjustment to elevation of pole $+58' 23''$
Supplemental adjustment $0^{\circ} 00'$

Latitude of station $35^{\circ} 27' 05'' N.$

J - 1

ALTITUDE OBSERVATION OF THE SUN FOR AZIMUTH

Date: Aug. 29, 1944

Observer: A.W. Brown

Instrument: Buff No 23815

Recorder: R.C. Dice

Timer: W.C. Gale

FINAL FIELD NOTES

Aug. 29, 1944, in camp in sec. 19, T. 45 N., R. 5 E., N.W. 1/4, Colo., in latitude $38^{\circ} 08' N.$, longitude $106^{\circ} 21.1' W.$, with barometer at 22.1 ins. and thermometer approx. $77^{\circ} F.$, I make a set of three altitude observations of the sun for azimuth, each with the telescope in direct and reversed positions, observing opposite limbs of the sun and reading the horizontal deflection angles from a flag previously set approx. SOUTH of my instrument, to the sun.

Observation	Telescope	Sun	Watch time m.w.t.	Vertical angle	For. angle flag to sun
1st	Direct	$\frac{1}{2}$	8h 39m 31s	$24^{\circ} 11' 00''$	$82^{\circ} 36' 00''$
6th	Reversed	$\frac{1}{2}$	8h 44m 26s	$24^{\circ} 37' 00''$	$82^{\circ} 21' 00''$
Mean		$\frac{1}{2}$	8h 41m 58.5s	$24^{\circ} 24' 00''$	$82^{\circ} 28' 30''$
2nd	Direct	$\frac{1}{2}$	8h 40m 29s	$24^{\circ} 22' 00''$	$82^{\circ} 27' 00''$
5th	Reversed	$\frac{1}{2}$	8h 43m 39s	$24^{\circ} 28' 00''$	$82^{\circ} 29' 00''$
Mean		$\frac{1}{2}$	8h 42m 04s	$24^{\circ} 25' 00''$	$82^{\circ} 28' 00''$
3rd	Direct	$\frac{1}{2}$	8h 41m 20s	$24^{\circ} 32' 00''$	$82^{\circ} 18' 00''$
4th	Reversed	$\frac{1}{2}$	8h 42m 41s	$24^{\circ} 18' 00''$	$82^{\circ} 39' 00''$
Mean		$\frac{1}{2}$	8h 42m 0.5s	$24^{\circ} 25' 00''$	$82^{\circ} 28' 30''$

By 1st observation: flag bears S. $0^{\circ} 0' 24''$ E.By 2nd observation: flag bears S. $0^{\circ} 0' 02''$ E.By 3rd observation: flag bears S. $0^{\circ} 0' 28''$ E.Mean: true bearing of flag = S. $0^{\circ} 0' 01''$ W.

TIME CALCULATION

Mean, m.w.t. of observations 8h 42m 1s.

Watch fast of app. time 1h 5m 1s.

Apparent time of observations 7h 37m 0s.

DECLINATION CALCULATION

Sun's decl., Gr. app. noon $9^{\circ} 18' 43.6''$ N.Hourly difference $53.79''$ Red. to long. $106^{\circ} 21.1' W.$: 7h 5m 24s.

Red. to time of obsn. 4h 23m 00s.

2.7h = 2h 42m 24s.

 $2.71 \times 53.79 = 2^{\circ} 24.7''$ Decl. of mean sun for period of obsn. $9^{\circ} 16' 18.9''$

REDUCTION TO TRUE VERTICALS.

	1st Obsn.	2nd Obsn.	3rd Obsn.
v.	$24^{\circ} 24' 00''$	$24^{\circ} 25' 00''$	$24^{\circ} 25' 00''$
Ref.	$-1' 30.2''$	$-1' 30.1''$	$-1' 30.1''$
Parallax +	$8.0''$	$+ 8.0''$	$+ 8.0''$
h	$24^{\circ} 22' 37.8''$	$24^{\circ} 23' 37.9''$	$24^{\circ} 23' 37.9''$

AZIMUTH CALCULATIONS

1st observation reduced by the equation:

$$\cos A = \frac{\sin}{\cos \delta \cos h} - \tan \delta \tan h$$

$$\begin{aligned} \{ 6 = 9^{\circ} 16' 18.9'' : \delta = 38^{\circ} 08' 00'' : h = 24^{\circ} 22' 37.8'' \\ \log \cos \delta \quad 9.805741 \quad \log \sin 6 \quad 9.207148 \quad \log \tan \delta \quad 9.894892 \\ \quad \quad \quad 9.952446 \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad 9.656232 \\ \quad \quad \quad 9.855187 \quad \quad \quad 9.85187 \quad \quad \quad \log \quad 9.551124 \\ \quad \quad \quad \log \quad 9.351951 \quad \quad \quad \text{nat. } (-) \quad .35573 \\ \quad \quad \quad \text{nat } (+) \quad .22499 \quad \quad \quad (+) \quad .22499 \\ \cos A \quad (-) \quad 0.13004 \end{aligned}$$

A = true bearing of sun = S. 82° 28' 54" E.
 Angle from flag to sun = 82° 28' 30"
 True bearing of flag = S. 0° 0' 24" E.

2nd Observation Reduced by same Formula:

A = true bearing of sun = S. 82° 28' 02" E.
 Angle from flag to sun = 82° 28' 00"
 True bearing of flag = S. 0° 0' 02" E.

3rd Observation Reduced by same Formula:

A = true bearing of sun = S. 82° 28' 02" E.
 Angle from flag to sun = 82° 28' 30"
 True bearing of flag = S. 0° 0' 28" E.

Average of Obsns. 1, 2 and 3:

True bearing of flag: S. 0° 0' 1" W.

AZIMUTH CALCULATION

1st Observation Reduced by the Equations:

$$\cos \frac{1}{2}A = \frac{\sin S \sin (S - \text{co-decl.})}{\sin \text{co-lat.} \sin \text{co-alt.}}$$

$$\begin{aligned} 90^\circ - \beta &= 90^\circ - 38^\circ 08' 00'' = 51^\circ 52' 00'' = \text{co-lat.} \\ 90^\circ - S &= 90^\circ - 9^\circ 16' 18.9'' = 80^\circ 43' 41.1'' = \text{co-decl.} \\ 90^\circ - h &= 90^\circ - 24^\circ 22' 37.8'' = 65^\circ 37' 22.2'' = \text{co-alt.} \end{aligned}$$

$$2S = 19^\circ 13' 3.3''$$

$$S = 9^\circ 06' 31.6''$$

$$\text{co-decl.} = 80^\circ 43' 41.1''$$

$$S - \text{co-decl.} = 18^\circ 22' 50.5''$$

$$\begin{aligned} \log \sin S &= 9.994489 \\ \log \sin S \cos \text{co-decl.} &= 9.498765 \end{aligned}$$

$$\text{" " co-lat.} = 9.895741 \quad 9.493254$$

$$\text{" " co-alt.} = 9.959446$$

$$\frac{9.8955187}{9.8955187} \quad 9.855187$$

$$\log \cos \frac{1}{2}A = 9.638067$$

$$\log \cos \frac{1}{2}A = 9.819033$$

$$\frac{1}{2}A = 48^\circ 45' 33''$$

A; true bearing of sun = 180° - 97° 31' 6" = S. 82° 28' 54" E.
 (Checks calc. by 1st formula)

AZIMUTH CALCULATION

1st Observation Reduced by the Equations:

$$\tan \frac{1}{2}A = \sqrt{\frac{\cos \frac{1}{2}(\zeta + \beta + \delta) \sin \frac{1}{2}(\zeta + \beta - \delta)}{\cos \frac{1}{2}(\zeta - \beta - \delta) \sin \frac{1}{2}(\zeta - \beta + \delta)}}$$

$$h = 24^\circ 22' 37.8''$$

$$S = 65^\circ 37' 22.2''$$

$$\beta = 38^\circ 08' 00''$$

$$\zeta = 65^\circ 37' 22.2''$$

$$\beta = 38^\circ 08' 00''$$

$$\zeta + \beta = 103^\circ 35' 22.2''$$

$$\zeta - \beta = 27^\circ 29' 22.2''$$

$$\zeta = 9^\circ 16' 18.9'' (+)$$

$$\zeta = 9^\circ 16' 18.9'' (+)$$

$$\zeta + \beta + \delta = 113^\circ 01' 41.1''$$

$$\zeta - \beta + \delta = 28^\circ 45' 41.1''$$

1. The first part of the problem is to find the value of x which satisfies the equation $x^2 + 1 = 0$. This is a quadratic equation, and we can solve it by using the quadratic formula.

2. The second part of the problem is to find the value of y which satisfies the equation $y^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

3. The third part of the problem is to find the value of z which satisfies the equation $z^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

4. The fourth part of the problem is to find the value of w which satisfies the equation $w^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

5. The fifth part of the problem is to find the value of v which satisfies the equation $v^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

6. The sixth part of the problem is to find the value of u which satisfies the equation $u^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

7. The seventh part of the problem is to find the value of t which satisfies the equation $t^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

8. The eighth part of the problem is to find the value of s which satisfies the equation $s^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

9. The ninth part of the problem is to find the value of r which satisfies the equation $r^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

10. The tenth part of the problem is to find the value of q which satisfies the equation $q^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

11. The eleventh part of the problem is to find the value of p which satisfies the equation $p^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

12. The twelfth part of the problem is to find the value of o which satisfies the equation $o^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

13. The thirteenth part of the problem is to find the value of n which satisfies the equation $n^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

14. The fourteenth part of the problem is to find the value of m which satisfies the equation $m^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

15. The fifteenth part of the problem is to find the value of l which satisfies the equation $l^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

16. The sixteenth part of the problem is to find the value of k which satisfies the equation $k^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

17. The seventeenth part of the problem is to find the value of j which satisfies the equation $j^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

18. The eighteenth part of the problem is to find the value of i which satisfies the equation $i^2 + 1 = 0$. This is also a quadratic equation, and we can solve it by using the quadratic formula.

$$\frac{1}{2}(C + \beta + \epsilon) = 56^\circ 30' 51'' \quad \frac{1}{2}(C - \beta + \epsilon) = 18^\circ 22' 51''$$

$$C + \beta = 103^\circ 45' 22.2'' \quad C - \beta = 27^\circ 29' 22.2''$$

$$C = 9^\circ 16' 18.9'' (+) \quad C = 9^\circ 16' 18.9'' (+)$$

$$C + \beta - C = 94^\circ 29' 03.3'' \quad C - \beta - C = 18^\circ 13' 03.3''$$

$$\frac{1}{2}(C + \beta - C) = 47^\circ 14' 32'' \quad \frac{1}{2}(C - \beta - C) = 9^\circ 06' 32''$$

$$\begin{aligned} \log \cos \frac{1}{2}(C + \beta + \epsilon) &= 9.741727 \\ \text{" sin } \frac{1}{2}(C + \beta - C) &= \underline{9.865822} \\ \text{" cos } \frac{1}{2}(C - \beta - C) &= 9.994488 \\ \text{" sin } \frac{1}{2}(C - \beta + C) &= \underline{9.498768} \\ \log \tan^2 \frac{1}{2}A &= \frac{9.493256}{(-)9.493256} \\ \log \tan \frac{1}{2}A &= \underline{0.114303} \\ \frac{1}{2}A &= \underline{0.0571515} \\ &= 48^\circ 45' 33'' \end{aligned}$$

A; true bearing of sun $180^\circ - 97^\circ 31' 6'' = 82^\circ 28' 54''$ N.

(Check calc. by 1st and 2nd formulae)

TIME CALCULATION

1st Observation Reduced by the Formula:

$$\tan \frac{1}{2}t = \frac{\sin \frac{1}{2}(C + \beta - \epsilon) \sin \frac{1}{2}(C - \beta + \epsilon)}{\sqrt{\cos \frac{1}{2}(C + \beta + \epsilon) \cos \frac{1}{2}(C - \beta - \epsilon)}}$$

$$\begin{aligned} \log \sin \frac{1}{2}(C + \beta - \epsilon) &= 9.865822 \\ \text{" " } \frac{1}{2}(C - \beta + \epsilon) &= \underline{9.498768} \\ \text{" cos } \frac{1}{2}(C + \beta + \epsilon) &= 9.741727 \\ \text{" " } \frac{1}{2}(C - \beta - \epsilon) &= \underline{9.994488} \\ &= 9.736215 \quad \underline{9.736215} \\ \text{" tan } \frac{1}{2}t &= 0.628775 \\ \text{" " } \frac{1}{2}t &= \underline{9.8141675} \\ \frac{1}{2}t &= 33^\circ 06' 2.5'' \\ t &= 66^\circ 12' 5'' = \underline{4h 24m 40s} \end{aligned}$$

App. time of observation = 7h 35m 11s.
 Equation of time = On 50s.
 Local mean time of observation = 7h 36m 1 s., a.m.
 Watch time of observation, m.w.t. = 8h 41m 58.5s.
 Watch fast of l.m.t. = 1h 5m 57.5s.

Example of direct altitude observation of the sun for azimuth and time; sun in north declination, and south of an east and west line:

Observer: R. C. Yundt

Instrument: Buff and Buff No. 14191

August 4, 1944, at a point 35 links south of the corner of Tps. 7 and 8 N., Re. 1 and 2 E., Salt Lake Meridian, Utah, in latitude $41^{\circ}28'40''$ N., and longitude $111^{\circ}46'40''$ W., in order to verify the alignment of my random north boundary, (S. $89^{\circ}59'$ W.), I make a series of three altitude observations of the sun for azimuth, each with the telescope in direct and reversed positions, observing opposite limbs of the sun, and reading the horizontal angle from a flag on my line to the east, southward to the sun. My watch carries mountain standard war time.

Obsn.	Telescope	Sun	Watch time	Vertical angle	Horizontal angle flag to sun
1st	Direct	+	10h42m03s a.m.	$46^{\circ}34'00''$	$21^{\circ}00'00''$
set	Reversed	-	10 42 59 a.m.	$46^{\circ}10'00''$	$20^{\circ}29'00''$
	Mean		10 42 32 a.m.	$46^{\circ}22'00''$	$20^{\circ}44'30''$
2nd	Direct	+	10h44m02s a.m.	$46^{\circ}54'00''$	$21^{\circ}28'00''$
set	Reversed	-	10 44 36 a.m.	$46^{\circ}26'00''$	$20^{\circ}49'00''$
	Mean		10 44 19 a.m.	$46^{\circ}40'00''$	$21^{\circ}08'30''$
3rd	Direct	+	10h45m41s a.m.	$47^{\circ}12'00''$	$21^{\circ}52'00''$
set	Reversed	-	10 46 20 a.m.	$46^{\circ}45'00''$	$21^{\circ}16'00''$
	Mean		10 46 00 a.m.	$46^{\circ}58'30''$	$21^{\circ}34'00''$

By the 1st observation the flag bears N. $89^{\circ}59'10''$ E.

By the 2nd observation the flag bears N. $89^{\circ}59'23''$ E.

By the 3rd observation the flag bears N. $89^{\circ}59'09''$ E.

Mean true bearing of the flag - N. $89^{\circ}59'14''$ E.

Watch slow M.S.W. time 0331s

The declination of the sun for the mean period of the three observations is $17^{\circ}09'30''$ N.

The following reductions are made to obtain the true vertical angles of the above observations:

	1st obsn.	2nd obsn.	3rd obsn.
v	$46^{\circ}22'00''$	$46^{\circ}40'00''$	$46^{\circ}58'30''$
Refraction	-55"	-55"	-54"
Parallax	+06"	+06"	+06"
h	$46^{\circ}21'11''$	$46^{\circ}39'11''$	$46^{\circ}57'42''$

The following examples of reduction are all by the equation:

$$\cos A = \frac{\sin \delta}{\cos \beta \cos h} - \tan \beta \tan h$$

1st set:					
log cos β	9.875274	log sin δ	9.469842	log tan β	9.944941
log cos h	9.838983			log tan h	0.020519
log	9.714257	log	9.714257	log	9.965460
		log	9.755585	nat -	.92355
		nat +	.56962	nat +	.56962
				cos A -	.333393
				True bearing of sun	S. $69^{\circ}16'20''$ E.
				Angle, flag to sun	S. $20^{\circ}44'30''$ E.
					S. $30^{\circ}00'30''$ E.
				True bearing of flag	N. $89^{\circ}59'10''$ E.

There is a large number of small islands in the area, some of which are of considerable size. The largest of these is the island of St. John, which is situated in the center of the group. It is a very fertile island, and is the only one in the group which has a permanent population. The other islands are all small and are mostly uninhabited.

Geography and Climate

The islands are situated in the Caribbean Sea, and are part of the Lesser Antilles. They are all of volcanic origin, and are mostly of basaltic lava. The climate is tropical, with a wet season from May to November and a dry season from December to April. The temperature is generally between 70 and 80 degrees Fahrenheit. The islands are all of considerable size, and are all of volcanic origin. The largest of these is the island of St. John, which is situated in the center of the group. It is a very fertile island, and is the only one in the group which has a permanent population. The other islands are all small and are mostly uninhabited.

History and Population

Island	Area (sq. mi.)	Population (1950)	Capital
St. John	14.0	1,200	St. John's
St. Peter	1.0	100	St. Peter's
St. Vincent	100.0	10,000	St. Vincent's
St. Lucia	180.0	15,000	St. Lucia's
St. Kitts	16.0	1,000	St. Kitts's
St. Eustace	160.0	1,000	St. Eustace's
St. Thomas	100.0	1,000	St. Thomas's
St. James	100.0	1,000	St. James's
St. George	100.0	1,000	St. George's
St. Andrew	100.0	1,000	St. Andrew's

The islands are all of volcanic origin, and are mostly of basaltic lava. The climate is tropical, with a wet season from May to November and a dry season from December to April. The temperature is generally between 70 and 80 degrees Fahrenheit. The islands are all of considerable size, and are all of volcanic origin. The largest of these is the island of St. John, which is situated in the center of the group. It is a very fertile island, and is the only one in the group which has a permanent population. The other islands are all small and are mostly uninhabited.

Government and Economy

The islands are all part of the same country, and are all of volcanic origin. The climate is tropical, with a wet season from May to November and a dry season from December to April. The temperature is generally between 70 and 80 degrees Fahrenheit. The islands are all of considerable size, and are all of volcanic origin. The largest of these is the island of St. John, which is situated in the center of the group. It is a very fertile island, and is the only one in the group which has a permanent population. The other islands are all small and are mostly uninhabited.

Island	Area (sq. mi.)	Population (1950)	Capital
St. John	14.0	1,200	St. John's
St. Peter	1.0	100	St. Peter's
St. Vincent	100.0	10,000	St. Vincent's
St. Lucia	180.0	15,000	St. Lucia's
St. Kitts	16.0	1,000	St. Kitts's
St. Eustace	160.0	1,000	St. Eustace's
St. Thomas	100.0	1,000	St. Thomas's
St. James	100.0	1,000	St. James's
St. George	100.0	1,000	St. George's
St. Andrew	100.0	1,000	St. Andrew's

Transportation and Communications

The islands are all part of the same country, and are all of volcanic origin. The climate is tropical, with a wet season from May to November and a dry season from December to April. The temperature is generally between 70 and 80 degrees Fahrenheit. The islands are all of considerable size, and are all of volcanic origin. The largest of these is the island of St. John, which is situated in the center of the group. It is a very fertile island, and is the only one in the group which has a permanent population. The other islands are all small and are mostly uninhabited.

Island	Area (sq. mi.)	Population (1950)	Capital
St. John	14.0	1,200	St. John's
St. Peter	1.0	100	St. Peter's
St. Vincent	100.0	10,000	St. Vincent's
St. Lucia	180.0	15,000	St. Lucia's
St. Kitts	16.0	1,000	St. Kitts's
St. Eustace	160.0	1,000	St. Eustace's
St. Thomas	100.0	1,000	St. Thomas's
St. James	100.0	1,000	St. James's
St. George	100.0	1,000	St. George's
St. Andrew	100.0	1,000	St. Andrew's

2nd set:
 log cos δ 9.875274 log sin δ 9.469842 log tan δ 9.944941
 log cos h 9.836586 log tan h 0.029762
 log 9.711860 log 9.711860 log 9.970011
 log 9.757982 nat - .93328
 nat + .57277 nat + .57277
 Cos A - .36051
 True bearing of sun S. 68°52'07" E.
 Angle, flag to sun +21°08'30"
 True bearing of flag N. 89°00'37" E.
 S. 90°00'37" E.
 N. 89°59'23" E.

3rd set:
 log cos δ 9.875274 log sin δ 9.469842 log tan δ 9.944941
 log cos h 9.834094 log tan h 0.029762
 log 9.709368 log 9.709368 log 9.974703
 log 9.760474 nat - .94342
 nat + .57607 nat + .57607
 Cos A - .36735
 True bearing of sun S. 68°26'51" E.
 Angle, flag to sun +21°34'00"
 True bearing of flag N. 90°00'51" E.
 S. 90°00'51" E.
 N. 89°59'09" E.

The first set of the above series is selected for an example of reduction by the equation:

$$\cos \frac{1}{2} A = \sqrt{\frac{\sin S \sin(S-\text{codec})}{\sin \text{colat.} \sin \text{codec.}}}$$

90°- δ 90°-41°22'40" = 48°37'20" = colat.
 90°- b 90°-17°09'30" = 72°50'30" = codec.
 90°- h 90°-46°21'11" = 43°38'49" = colat.
 $2 S$ = 165°06'39"
 S = 82°33'20"
 codec. = 72°50'30"
 S -codec. = 9°42'50"

log sin S 9.996324
 log sin (S-codec) 9.227188
 log 9.722552
 log sin colat. 9.875274
 log sin codec. 9.838983
 log 9.714237 9.714237
 log cos $\frac{1}{2} A$ 9.509255
 log cos δ A 9.754628
 log cos h A 55°21'49"
 A N. 110°43'38" E.
 True bearing of sun S. 69°16'22" E.
 Angle, flag to sun + 20°44'30"
 True bearing of flag N. 89°59'08" E.

The first set of the above series is again selected for an example of reduction by the equation:

$$\tan \frac{1}{2} A = \sqrt{\frac{\cos \frac{1}{2} (f + \beta + \delta) \sin \frac{1}{2} (f + \beta - \delta)}{\cos \frac{1}{2} (f - \beta + \delta) \sin \frac{1}{2} (f - \beta - \delta)}}$$

$h = 90^{\circ}00'00''$	$f = 43^{\circ}38'49''$
$\beta = 46^{\circ}21'11''$	$\delta = 41^{\circ}22'40''$
$f + \beta = 89^{\circ}59'59''$	$f - \beta = 2^{\circ}16'09''$
$\delta = 17^{\circ}09'30''$	$\delta = 17^{\circ}09'30''$
$f + \beta + \delta = 107^{\circ}10'59''$	$f - \beta + \delta = 19^{\circ}25'39''$
$\frac{1}{2}(f + \beta + \delta) = 53^{\circ}05'29''$	$\frac{1}{2}(f - \beta + \delta) = 9^{\circ}42'50''$
$f + \beta = 89^{\circ}59'59''$	$f - \beta = 2^{\circ}16'09''$
$\delta = 17^{\circ}09'30''$	$\delta = 17^{\circ}09'30''$
$f + \beta - \delta = 72^{\circ}50'29''$	$f - \beta - \delta = -14^{\circ}53'21''$
$\frac{1}{2}(f + \beta - \delta) = 36^{\circ}25'14''$	$\frac{1}{2}(f - \beta - \delta) = -7^{\circ}26'41''$
$\log \cos \frac{1}{2}(f + \beta + \delta)$	9.798012
$\log \sin \frac{1}{2}(f + \beta + \delta)$	9.746812
	9.544824
$\log \cos \frac{1}{2}(f - \beta + \delta)$	9.996324
$\log \sin \frac{1}{2}(f - \beta + \delta)$	9.227188
	9.223512
$\log \tan \frac{1}{2} A$	0.321312
$\log \tan \frac{1}{2} A$	0.160656
$\frac{1}{2} A$	55^{\circ}21'50''
True bearing of sun-	N. 110^{\circ}43'40'' E.
Angle, flag to sun	S. 69^{\circ}16'20'' E.
True bearing of flag N.	20^{\circ}44'30'' E.

The first set of the above series is likewise selected for an example for the computation for time by the equation:

$$\tan \frac{1}{2} t = \sqrt{\frac{\sin \frac{1}{2} (f + \beta - \delta) \sin \frac{1}{2} (f - \beta + \delta)}{\cos \frac{1}{2} (f + \beta + \delta) \cos \frac{1}{2} (f - \beta - \delta)}}$$

$\log \sin \frac{1}{2}(f + \beta - \delta)$	9.746812
$\log \sin \frac{1}{2}(f - \beta + \delta)$	9.227188
	9.974000
$\log \cos \frac{1}{2}(f + \beta + \delta)$	9.798012
$\log \cos \frac{1}{2}(f - \beta - \delta)$	9.996324
	9.794336
$\log \tan \frac{1}{2} t$	9.794336
$\log \tan \frac{1}{2} t$	9.179664
$\frac{1}{2} t$	9.589832
$\frac{1}{2} t$	21^{\circ}15'03''
$\frac{1}{2} t$	42^{\circ}30'06'' = 2h50m00s
Apparent time of observation	9h10m00s a.m.
Equation of time	+ 05m56s
Local mean time of observation	9h15m56s a.m.
Mountain standard war time of observation	10h43m03s a.m.
Watch time of observation	10h42m32s a.m.
Watch slow M.S.W. time	0m31s
Watch fast of l.m.t.	1h26m36s

The same set of the above series is selected for an example for the computation of time by the equation:

$$\sin t = \frac{\sin A \cos h}{\cos \delta}$$

$$\log \sin A \quad 9.970938$$

$$\log \cos h \quad 9.838983$$

$$\log \quad 9.809921$$

$$\log \cos \delta \quad 9.980228$$

$$\log \sin t \quad 9.829693$$

$$t = 42^{\circ}30'04'' = 2h50m00s$$

$$\text{Apparent time of observation} \quad 9h10m00s \text{ a.m.}$$

$$\text{Equation of time} \quad + \quad 5m56s$$

$$\text{Mountain standard war time of obsn.} \quad 10h43m02s \text{ a.m.}$$

$$\text{Watch time of observation} \quad 10h42m32s \text{ a.m.}$$

$$\text{Watch slow M.S.W. time} \quad 0m31s$$

$$\text{Watch fast of L.M.T.} \quad 1h26m36s$$

MEMO:

The above time equation is convenient when it is required to reduce the observation for azimuth also. However it should not be used when the hour angle approaches 6 hours (when t approaches 90°) as the sine function of an angle approaching 90° changes very slowly.

Example of direct altitude observation of the sun for azimuth.

Date: Sept. 20, 1944 Observer: James W. Harrison Instrument: Buff No. 17994

At a point 9.00 chains westerly from the standard $\frac{1}{4}$ sec. cor., on south boundary of T. 6 N., R. 30 E., Mount Diablo Meridian, Nevada, in latitude $38^{\circ} 19' 45''$ N., and longitude $118^{\circ} 35'$ W., at $7^h 37^m$ a.m., app. t., I make a series of four altitude observations upon the sun for azimuth, each with the telescope in direct and reversed positions, observing the sun's center, and reading the horizontal deflection angle from the sun to a reference point to the south.

Observations commenced at $7^h 30^m$ a.m., and completed at $7^h 30$ a.m., mean $7^h 30^m$ a.m., by my watch which carries correct 120th meridian standard time.

Obm.	Telescope	Sun	Vertical angle	Horizontal angle from sun to reference point
1st	Direct	+	$19^{\circ} 23'$	$89^{\circ} 00'$
	Reversed		$19^{\circ} 33'$	$88^{\circ} 52'$
	Mean		$19^{\circ} 28'$	$88^{\circ} 56'$
2nd	Reversed	+	$19^{\circ} 36'$	$88^{\circ} 48'$
	Direct		$19^{\circ} 46'$	$88^{\circ} 40'$
	Mean		$19^{\circ} 41'$	$88^{\circ} 44'$
3rd	Direct	+	$19^{\circ} 51'$	$88^{\circ} 35'$
	Reversed		$20^{\circ} 02'$	$88^{\circ} 27'$
	Mean		$19^{\circ} 55\frac{1}{2}'$	$88^{\circ} 31'$
4th	Reversed	+	$20^{\circ} 09'$	$88^{\circ} 18'$
	Direct		$20^{\circ} 17'$	$88^{\circ} 12'$
	Mean		$20^{\circ} 13'$	$88^{\circ} 15'$

By 1st obsn. reference point bears $S. 13^{\circ} 44' 28''$ W.
 By 2nd " " " " " $S. 13^{\circ} 44' 24''$ W.
 By 3rd " " " " " $S. 13^{\circ} 44' 43''$ W.
 By 4th " " " " " $S. 13^{\circ} 44' 49''$ W.

Mean true bearing of reference point, $S. 13^{\circ} 44' 36''$ W.

The declination of the sun for the mean period of the four observations = $0^{\circ} 59'$ N.

The following reductions are all by the equation

$$\cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h$$

log sin. dec.	8.234557		
log cos. lat.	9.864571		
log of quotient	8.339906	log tan lat.	9.897945
log cos. h	9.974590	log tan h	9.547312
	8.365436 = nat.	.02320	9.445257

$\phi = 19^{\circ} 28'$		
ref. = $2^{\circ} 42' (-)$	nat.	.27878
par. = $08' (+)$	nat.	.02320
$h = 19^{\circ} 25' 26''$	cos A =	.25558
	A =	$87^{\circ} 11' 32''$ E.
	Hor. ang =	$88^{\circ} 56'$
	Bearing =	$S 13^{\circ} 44' 28''$ W.

1. The first part of the report deals with the general situation of the country and the position of the various groups of the population.

2. The second part of the report deals with the economic situation of the country and the position of the various groups of the population.

3. The third part of the report deals with the social situation of the country and the position of the various groups of the population.

4. The fourth part of the report deals with the cultural situation of the country and the position of the various groups of the population.

No.	Name	Age	Sex	Marital Status	Occupation	Income	Expenses	Savings	Debt	Assets	Liabilities	Net Worth
1	John Doe	35	M	Married	Teacher	\$1,200	\$1,000	\$200	\$0	\$1,000	\$0	\$1,000
2	Jane Doe	32	F	Married	Homemaker	\$0	\$1,000	\$0	\$0	\$0	\$0	\$0
3	John Smith	45	M	Married	Engineer	\$2,500	\$2,000	\$500	\$0	\$2,000	\$0	\$2,000
4	Jane Smith	42	F	Married	Homemaker	\$0	\$2,000	\$0	\$0	\$0	\$0	\$0
5	John Brown	55	M	Married	Retired	\$1,500	\$1,200	\$300	\$0	\$1,200	\$0	\$1,200
6	Jane Brown	52	F	Married	Homemaker	\$0	\$1,200	\$0	\$0	\$0	\$0	\$0
7	John Black	65	M	Married	Retired	\$1,000	\$800	\$200	\$0	\$800	\$0	\$800
8	Jane Black	62	F	Married	Homemaker	\$0	\$800	\$0	\$0	\$0	\$0	\$0
9	John White	75	M	Married	Retired	\$800	\$600	\$200	\$0	\$600	\$0	\$600
10	Jane White	72	F	Married	Homemaker	\$0	\$600	\$0	\$0	\$0	\$0	\$0

5. The fifth part of the report deals with the political situation of the country and the position of the various groups of the population.

6. The sixth part of the report deals with the legal situation of the country and the position of the various groups of the population.

7. The seventh part of the report deals with the health situation of the country and the position of the various groups of the population.

8. The eighth part of the report deals with the education situation of the country and the position of the various groups of the population.

9. The ninth part of the report deals with the environment situation of the country and the position of the various groups of the population.

10. The tenth part of the report deals with the international situation of the country and the position of the various groups of the population.

11. The eleventh part of the report deals with the future of the country and the position of the various groups of the population.

12. The twelfth part of the report deals with the conclusion of the report and the position of the various groups of the population.

13. The thirteenth part of the report deals with the appendix of the report and the position of the various groups of the population.

14. The fourteenth part of the report deals with the bibliography of the report and the position of the various groups of the population.

15. The fifteenth part of the report deals with the index of the report and the position of the various groups of the population.

log of quotient	8.339986	log tan lat	9.897945
log cos. h	9.973969	log tan h	9.552550
	8.366021 = nat. .02323	nat.	9.450495
v = 19° 41'		nat.	.28216
ref. = 2' 38" (-)		nat.	.02323
par. = 08" (+)		cos A =	.25893
h = 19° 38' 30"		A = S.	74° 59' 36" E.
		Hor. ang. =	88° 44'
		Bearing = S.	13° 44' 24" W.

log of quotient	8.339986	log tan lat	9.897945
log cos. h	9.973307	log tan h	9.553508
	8.366579 = nat. .02326	nat.	9.456253
v = 19° 55' 30"		nat.	.28593
ref. = 2' 38" (-)		cos A =	.26267
par. = 08" (+)		A = S.	74° 46' 17" E.
h = 19° 53'		Hor. ang. =	88° 31'
		Bearing = S.	13° 44' 43" W.

log of quotient	8.339986	log tan lat	9.897945
log cos. h	9.972499	log tan h	9.553198
	8.367497 = nat. .02331	nat.	9.463143
v = 20° 13'		nat.	.29090
ref. = 2' 35" (-)		cos A =	.26719
par. = 08" (+)		A = S.	74° 30' 11" E.
h = 20° 10' 33"		Hor. ang. =	88° 15'
		Bearing = S.	13° 44' 49" W.

Altitude observation of the sun for azimuth.

This observation is the solar observation commonly used by myself in the field, both for the initiation of a line and for the verification of the azimuth of a line previously run. It differs from the commonly used observing program in certain respects; angles are read to the sun's center, obtained by a careful comparison of the size of that portion of the sun above the upper stadia wire with the corresponding portion of the sun below the lower stadia wire (vertical center), and comparing that portion of each of the above referred to portions of the sun's image that appear on each side of the center vertical wire. The resultant determination of the sun's center is slightly less accurate in vertical position than in horizontal position, albeit not appreciably so. The sighting of the sun's center results in the cross wires of the transit being brightly illuminated regardless of how dark the glass is which is not true when setting tangent to the edge of the sun, and has, for myself, resulted in a more accurate determination of azimuth by the solar method.

Another difference is in sighting with the telescope in reversed position first on alternate observations, reducing the time elapsed in the observation and allowing for a checking of the zero setting of the plate of the transit in the middle of each pair of observations without increasing the elapsed time of the observation to more than 5 or six minutes for a series of eight sighting (four observations.)

As a saving of time when required to reduce the observation in the field (as when initiating a line of survey) the factor sin dec. divided by cos. lat. is first reduced and then is used as a factor common to the entire series of observations.

Example of altitude observation of the sun for azimuth, using morning and afternoon observations:

Date: August 9, 1938.

Instrument: Gurley No. 371615

Observer: Arthur D. Kidder.

Recorder: Frank Robertson.

Transcribed field notes.

August 9, 1938, at observation station No. 1, a cross in the sidewalk on the south side of G Street, opposite the south entrance to the Interior Building, Washington, D. C., in latitude $38^{\circ} 53' 30''$ N., and longitude $77^{\circ} 02' W.$, elevation above sea level 10 ft., and temperature $80^{\circ} F.$, at $8^h 55^m$ a.m., and $3^h 32^m$ p.m., I make series of altitude observations of the sun for azimuth, each series consisting of six observations, three each with the telescope in direct and reversed positions, observing opposite limbs of the sun, and reading the horizontal angle from the tip of the Washington Monument, approximately 40 obs. southeasterly, to the left to the sun in the a.m., and to the right to the sun in the p.m.:

Observation.	Telescope.	Sun.	Apparent time.	Vertical angle.	Horizontal angle monument to sun.
1st	Direct	☐ ☐	$8^h 54^m 00^s$ a.m.	$43^{\circ} 39' 00''$	$18^{\circ} 19' 00''$ to lt.
	Reversed		$9 03 50$ "	$46 00 00$	$16 55 30$ " "
	Mean			$44^{\circ} 19' 30''$	$17^{\circ} 37' 15''$ to lt.
2nd	Direct	☐ ☐	$8^h 55^m 30^s$ a.m.	$44^{\circ} 28' 00''$	$18^{\circ} 44' 00''$ to lt.
	Reversed		$9 02 15$ "	$45 11 00$	$16 31 00$ " "
	Mean			$44^{\circ} 19' 30''$	$17^{\circ} 37' 30''$ to lt.
3rd	Direct	☐ ☐	$8^h 57^m 00^s$ a.m.	$44^{\circ} 12' 00''$	$17^{\circ} 41' 30''$ to lt.
	Reversed		$9 00 20$ "	$45 21 30$	$17 41 30$ " "
	Mean		$8^h 56^m 49^s$ a.m.	$44^{\circ} 46' 45''$	$17^{\circ} 41' 30''$ to lt.
1st	Direct	☐ ☐	$3^h 31^m 35^s$ p.m.	$38^{\circ} 44' 30''$	$133^{\circ} 25' 00''$ to rt.
	Reversed		$3 42 05$ "	$37 15 00$	$134 42 00$ " "
	Mean			$37^{\circ} 59' 45''$	$134^{\circ} 03' 30''$ to rt.
2nd	Direct	☐ ☐	$3^h 34^m 00^s$ p.m.	$38^{\circ} 58' 00''$	$133^{\circ} 01' 00''$ to rt.
	Reversed		$3 40 30$ "	$37 02 00$	$135 03 45$ " "
	Mean			$38^{\circ} 00' 00''$	$134^{\circ} 02' 22''$ to rt.
3rd	Direct	☐ ☐	$3^h 35^m 15^s$	$38^{\circ} 03' 00''$	$134^{\circ} 06' 00''$ to rt.
	Reversed		$3 38 45$	$37 53 30$	$134 05 00$ " "
	Mean		$3^h 37^m 02^s$	$37^{\circ} 58' 15''$	$134^{\circ} 05' 30''$ to rt.

By 1st a.m. observation monument bears S. $54^{\circ} 42' 03''$ E.

" 2nd " " " " S. $54^{\circ} 41' 48''$ E.

" 3rd " " " " " S. $54^{\circ} 41' 00''$ E.

Mean of a.m. obsns. S. $54^{\circ} 41' 37''$ E.

By 1st p.m. observation monument bears S. $54^{\circ} 39' 25''$ E.

" 2nd " " " " " S. $54^{\circ} 38' 32''$ E.

" 3rd " " " " " S. $54^{\circ} 32' 50''$ E.

Mean of p.m. obsns. S. $54^{\circ} 39' 16''$ E.

Mean, true bearing of monument S. $54^{\circ} 40' 26''$ E.

Memo:

Accepted bearing of monument (weighted mean) = S. $54^{\circ} 40' 25''$ E.

Field record.

The above observations are reduced for azimuth by the equation:

$$\cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h.$$

1st series, a.m. observations:

Sun's declination, Gr. app. noon, August 9, 1938 $15^{\circ} 58' 32''$ N.
 Red. to long. $77^{\circ} 02'$ W., and $8^h 58^m 49^s$ a.m., $2.12^h \times 42''$ 1 29 S.

Sun's declination for mean time of observations, δ $15^{\circ} 57' 03''$ N.

Latitude, $\phi = 38^{\circ} 53' 30''$ N. Refraction coef. = $1.01 \times .94 = .95$

1st obsn.:

v = $44^{\circ} 49' 30''$
 Refraction ($58'' \times .95 = 55''$) ... = - 0 55
 Parallax = + 0 6
 h = $44^{\circ} 48' 41''$

Sin. δ = .274812

Cos ϕ = .778335

Cos h = .704431

.552175

.552175

$\tan \phi$ = .806658

$\tan h$ = .993438

-.801365

.497690

.497690

cos A = -.303675

A = S. $72^{\circ} 19'$ 18" E.

Hor. ang. = 17 37 15

By 1st a.m. obsn. monument bears

" 2nd " " " "

" 3rd " " " "

S. $54^{\circ} 42'$ 03" E.

S. $54^{\circ} 41'$ 48" E.

S. $54^{\circ} 41'$ 00" E.

Mean S. $54^{\circ} 41'$ 37" E.

2nd series, p.m. observations:

Sun's declination, Gr. app. noon, August 9, 1938 $15^{\circ} 58' 32''$ N.
 Red. to long. $77^{\circ} 02'$ W. and $3^h 37^m 02^s$ p.m., $8.75^h \times 42''$ 6 08 S.

Sun's declination for mean time of observations, δ $15^{\circ} 52' 24''$ N.

Refraction coef. = $1.01 \times .94 = .95$

By 1st p.m. obsn. monument bears

" 2nd " " " "

" 3rd " " " "

S. $54^{\circ} 39'$ 25" E.

S. $54^{\circ} 38'$ 32" E.

S. $54^{\circ} 39'$ 50" E.

Mean S. $54^{\circ} 39'$ 16" E.

Mean of a.m. and p.m. obsns.

S. $54^{\circ} 40'$ 26" E.

CHAPTER 10

The first part of the chapter is devoted to the study of the

of the second part of the chapter is devoted to the study of the

of the third part of the chapter is devoted to the study of the

of the fourth part of the chapter is devoted to the study of the

of the fifth part of the chapter is devoted to the study of the

of the sixth part of the chapter is devoted to the study of the

of the seventh part of the chapter is devoted to the study of the

of the eighth part of the chapter is devoted to the study of the

of the ninth part of the chapter is devoted to the study of the

of the tenth part of the chapter is devoted to the study of the

of the eleventh part of the chapter is devoted to the study of the

of the twelfth part of the chapter is devoted to the study of the

of the thirteenth part of the chapter is devoted to the study of the

of the fourteenth part of the chapter is devoted to the study of the

of the fifteenth part of the chapter is devoted to the study of the

of the sixteenth part of the chapter is devoted to the study of the

of the seventeenth part of the chapter is devoted to the study of the

of the eighteenth part of the chapter is devoted to the study of the

of the nineteenth part of the chapter is devoted to the study of the

Date - June 28, 1944

Observer - F. W. Williamson

Instrument - W. and L. E.
Curley No. 38105

June 28, 1944, at a point 2 chains South of cor. No. 2, Survey No. 2638, Aniak, Alaska, in latitude $61^{\circ}34'38''$ North, longitude $159^{\circ}42'51''$ West, at a mean time of 7 hrs. 17 min. P.M., 135° meridian time, I make a series of four (4) altitude observations of the sun for azimuth, each with the telescope in direct and reverse positions, observing opposite limbs of the sun, and reading the horizontal deflection angle from the flag to the sun:

Observation	Telescope	Sun	Time 135° P.M.	Vertical angle	Horizontal angle flag to sun to left
1st	direct	☉	7 h 12 m	$23^{\circ}33'00''$	$8^{\circ}12'00''$
1st	reverse	☿		$23^{\circ}55'30''$	$8^{\circ}29'00''$
	mean			$23^{\circ}44'15''$	$8^{\circ}20'30''$
2nd	reverse	☉	7 h 16 m	$23^{\circ}14'00''$	$7^{\circ}36'00''$
2nd	direct	☿		$23^{\circ}36'00''$	$7^{\circ}53'00''$
	mean			$23^{\circ}25'00''$	$7^{\circ}44'30''$
3rd	direct	☉	7 h 18 m	$22^{\circ}42'30''$	$6^{\circ}38'30''$
3rd	reverse	☿		$23^{\circ}04'30''$	$6^{\circ}58'00''$
	mean			$22^{\circ}53'30''$	$6^{\circ}48'15''$
4th	reverse	☉		$22^{\circ}26'30''$	$6^{\circ}10'00''$
4th	direct	☿	7 h 22 m	$22^{\circ}46'30''$	$6^{\circ}25'30''$
	mean			$22^{\circ}36'30''$	$6^{\circ}17'45''$

Reference point is radio beacon at edge of Aniak Air Field.

By 1st observation beacon bears N. $76^{\circ}14'28''$ W.
 By 2nd observation beacon bears N. $76^{\circ}15'30''$ W.
 By 3rd observation beacon bears N. $76^{\circ}14'33''$ W.
 By 4th observation beacon bears N. $76^{\circ}14'17''$ W.
 Mean true bearing of beacon N. $76^{\circ}14'42''$ W.

Field record

The declination of the sun for mean time 7 h 17 m P.M. 135° time for the period of the four (4) observations is $23^{\circ}14'47''$ N.

	1st obs.	2nd obs.	3rd obs.	4th obs.
ref. and	$23^{\circ}44'15''$	$23^{\circ}25'00''$	$22^{\circ}53'30''$	$22^{\circ}36'30''$
parallax	$2'04''$	$2'06''$	$2'10''$	$2'11''$
h =	$23^{\circ}42'11''$	$23^{\circ}22'54''$	$22^{\circ}51'20''$	$22^{\circ}34'19''$

1st observation reduction by the equation

$$\cos \frac{1}{2} A = \frac{\sin S \sin (S - \text{codecl.})}{\sin \text{obs.} \sin \text{codecl.}}$$

$$\begin{aligned} 90^{\circ} - S &= 90^{\circ} - 61^{\circ}34'38'' = 28^{\circ}25'22'' & \text{A.C. log sin } 0.322417 \\ 90^{\circ} - \text{codecl.} &= 90^{\circ} - 23^{\circ}14'47'' = 66^{\circ}45'13'' \\ 90^{\circ} - h &= 90^{\circ} - 23^{\circ}42'11'' = 66^{\circ}17'49'' & \text{A.C. log sin } 0.038275 \\ &28 &= 161.26124 \\ &S &= 80.44112 \\ &\text{codecl.} &= 66.45113 \\ S - \text{codecl.} &= 13^{\circ}58'59'' & \text{log sin } 9.994299 \\ && \text{log sin } 9.383160 \\ && 2) 9.738150 \\ && \hline && 9.354975 \end{aligned}$$

$$\frac{1}{2} A = 42^{\circ}17'29''$$

N. $84^{\circ}34'53''$ W. true bearing of sun
 $8^{\circ}20'30''$ angle from sun to beacon -
 N. $76^{\circ}14'28''$ W. True bearing to beacon.

REPORT OF THE SECRETARY OF AGRICULTURE
 TO THE HOUSE OF REPRESENTATIVES
 AND SENATE
 FOR THE YEAR 1964

Item	1964	1963	1962	1961	1960
1. Total	100.0	100.0	100.0	100.0	100.0
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.
21.
22.
23.
24.
25.
26.
27.
28.
29.
30.
31.
32.
33.
34.
35.
36.
37.
38.
39.
40.
41.
42.
43.
44.
45.
46.
47.
48.
49.
50.
51.
52.
53.
54.
55.
56.
57.
58.
59.
60.
61.
62.
63.
64.
65.
66.
67.
68.
69.
70.
71.
72.
73.
74.
75.
76.
77.
78.
79.
80.
81.
82.
83.
84.
85.
86.
87.
88.
89.
90.
91.
92.
93.
94.
95.
96.
97.
98.
99.
100.

... (faint text) ...

Item	1964	1963	1962	1961	1960
1. Total	100.0	100.0	100.0	100.0	100.0
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.
21.
22.
23.
24.
25.
26.
27.
28.
29.
30.
31.
32.
33.
34.
35.
36.
37.
38.
39.
40.
41.
42.
43.
44.
45.
46.
47.
48.
49.
50.
51.
52.
53.
54.
55.
56.
57.
58.
59.
60.
61.
62.
63.
64.
65.
66.
67.
68.
69.
70.
71.
72.
73.
74.
75.
76.
77.
78.
79.
80.
81.
82.
83.
84.
85.
86.
87.
88.
89.
90.
91.
92.
93.
94.
95.
96.
97.
98.
99.
100.

... (faint text) ...

Date - June 28, 1944 Observer - F. W. Williamson Instrument - W. and L. E.
 Gurley No. 38105

2nd Observation

28°25'22"	colat.	A.C. log sin 0.322417
66°45'13"	codecl.	
66°37'06"	coalt.	A.C. log sin 0.037212
<hr/>		
2)161°47'41"		
80°53'50"	S	log sin 9.994496
66°45'13"		
14°08'37"	S-codecl.	log sin 9.388022
		<hr/>
	cos $\frac{1}{2} A$	2)9.742117
		9.871072

$$\frac{1}{2} A = \frac{42^{\circ}00'00''}{2}$$

N. 84°00'00" W. true bearing of sun
 7°44'30" angle from sun to beacon
 W. 76°15'30" W. True bearing to beacon.

3rd Observation

28°25'22"	colat.	A.C. log sin 0.322417
66°45'13"	codecl.	
67°08'40"	coalt.	A.C. log sin 0.035511
<hr/>		
2)162°19'15"	coalt.	
81°09'37.5"		log sin 9.994812
66°45'13"		
14°24'24.5"		log sin 9.395855
		<hr/>
	cos $\frac{1}{2} A$	2)9.748595
		9.8714297

$$\frac{1}{2} A = \frac{41^{\circ}31'24''}{2}$$

N. 83°02'48" W. true bearing of sun
 6°48'15" angle sun to beacon
 W. 76°14'33" W. True bearing to beacon.

4th Observation

28°25'22"	colat.	A.C. log sin 0.322417
66°45'13"	codecl.	
67°25'41"	coalt.	A.C. log sin 0.034611
<hr/>		
2)162°36'15"		
81°18'08"		log sin 9.994977
66°45'13"		
14°32'55"		log sin 9.400022
		<hr/>
	cos $\frac{1}{2} A$	2)9.752026
		9.876013

$$\frac{1}{2} A = \frac{41^{\circ}16'01''}{2}$$

N. 82°32'02" W. true bearing of sun
 6°17'45" angle sun to beacon
 W. 76°14'17" W. True bearing to beacon.

1. The first part of the report is a general introduction to the subject of the study.

2. The second part of the report is a detailed description of the methods used in the study.

3. The third part of the report is a discussion of the results of the study.

4. The fourth part of the report is a conclusion and a list of references.

5. The fifth part of the report is a list of references.

6. The sixth part of the report is a list of references.

7. The seventh part of the report is a list of references.

June 29, 1944

Observer - F. W. Williamson Instrument - W. and L. E.
Curley No. 38105

June 29, 1944, at a point 2 chains South of cor. No. 2, Survey No. 2638, Aniak, Alaska, in latitude $61^{\circ}34'38''$ North, longitude $159^{\circ}42'51''$ West, at a mean time of 7 hrs. 25 min. A.M., 135° meridian time, I make a series of four (4) altitude observations of the sun for azimuth, each with the telescope in direct and reverse positions, observing opposite limbs of the sun, and reading the horizontal deflection angles from the flag to the sun;

Observ-	Telescope	Sun	Time 135° a.m.	Vertical angle	Horizontal angle flag to sun to right
1st	direct	♂	7 h 20 m	$17^{\circ}55'00''$	$150^{\circ}05'00''$
1st	reverse	♀		$17^{\circ}35'30''$	$149^{\circ}55'00''$
	mean			$17^{\circ}45'15''$	$150^{\circ}00'00''$
2nd	reverse	♂	7 h 22 m	$18^{\circ}15'00''$	$150^{\circ}42'00''$
2nd	direct	♀		$18^{\circ}04'00''$	$150^{\circ}48'30''$
	mean			$18^{\circ}09'30''$	$150^{\circ}45'15''$
3rd	direct	♂	7 h 25 m	$18^{\circ}52'00''$	$151^{\circ}52'00''$
3rd	reverse	♀		$18^{\circ}31'00''$	$151^{\circ}37'00''$
	mean			$18^{\circ}41'30''$	$151^{\circ}44'30''$
4th	reverse	♂	7 h 30 m	$19^{\circ}18'00''$	$152^{\circ}37'00''$
4th	direct	♀		$18^{\circ}54'00''$	$152^{\circ}20'00''$
	mean			$19^{\circ}06'00''$	$152^{\circ}28'30''$

Reference point is radio beacon at edge of Aniak Airfield.

By 1st observation beacon bears $N. 76^{\circ}13'58'' W.$
 By 2nd observation beacon bears $N. 76^{\circ}14'45'' W.$
 By 3rd observation beacon bears $N. 76^{\circ}15'30'' W.$
 By 4th observation beacon bears $N. 76^{\circ}14'44'' W.$
 Mean true bearing of beacon $N. 76^{\circ}14'44.5'' W.$

Field Record.

The declination of the sun for mean time 7 h 25 m A.M. 135° time for the period of the four (4) observations is $23^{\circ}13'04'' N.$

	1st obs.	2nd obs.	3rd obs.	4th obs.
ref. and	$17^{\circ}45'15''$	$18^{\circ}09'30''$	$18^{\circ}41'30''$	$19^{\circ}06'00''$
parallax	$2'52''$	$2'48''$	$2'43''$	$2'38''$
	$17^{\circ}42'23''$	$18^{\circ}06'42''$	$18^{\circ}38'47''$	$19^{\circ}03'22''$

Observations reduced by the equation

$$\cos \frac{1}{2} A = \sqrt{\frac{\sin S \sin (S - \text{codecl.})}{\sin \text{olat.} \sin \text{calt.}}}$$

$90^{\circ} - \delta = 90^{\circ} - 61^{\circ}34'38'' = 28^{\circ}25'22''$	A.C. log sin 0.322417
$90^{\circ} - \text{decl.} = 90^{\circ} - 23^{\circ}13'04'' = 66^{\circ}46'56''$	
$90^{\circ} - h = 90^{\circ} - 17^{\circ}42'23'' = 72^{\circ}17'37''$	A.C. log sin 0.021077
$28 = 167^{\circ}29'55''$	
$S = 83^{\circ}44'57.5''$	log sin 9.997411
codecl. = $66^{\circ}46'56''$	
$S - \text{codecl.} = 16^{\circ}58'01.5''$	log sin 9.465118

$$\cos^2 \frac{1}{2} A = \frac{9.866023}{9.903011}$$

$$\frac{1}{2} A = 36^{\circ}53'01.2''$$

N. $73^{\circ}46'02''$ E. true bearing of sun $150^{\circ}00'00''$ angle from sun to beaconN. $76^{\circ}13'58''$ W. True bearing to beacon 1st obs.

Date - June 29, 1944

Observer - F. W. Williamson

Instrument - W. and L. E.
Gurley No. 38105

2nd Observation

28°25'22"	oalt.	A.C. log sin 0.322417
66°46'56"	codeol.	
71°53'18"	oalt.	A.C. log sin 0.022070
<u>2)167°05'38"</u>		
83°32'10"	S	log sin 9.997240
66°46'56"		
<u>16°45'52"</u>	S-codeol.	log sin 9.460052
		<u>2)9.801779</u>
	cos $\frac{1}{2}$ A =	9.900389

$$\frac{1}{2} A = \frac{37^{\circ}15'15''}{2}$$

N. 74°30'30" E. true bearing of sun

150°45'15" angle from sun to beacon

$$\frac{74^{\circ}30'30''}{2}$$

N. 76°14'45" W. True bearing to beacon.

3rd Observation.

28°25'22"	oalt.	A.C. log sin 0.322417
66°46'56"	codeol.	
71°21'13"	oalt.	A.C. log sin 0.023416
<u>2)166°33'31"</u>		
83°16'45.5"	S	log sin 9.997005
66°46'56"		
<u>16°29'49.5"</u>	S-codeol.	log sin 9.453267
		<u>2)9.796105</u>
		9.696052

$$\frac{1}{2} A = \frac{37^{\circ}44'30''}{2}$$

N. 75°29'00" E. true bearing of sun

151°44'30" angle sun to beacon

$$\frac{75^{\circ}29'00''}{2}$$

N. 76°15'30" W. True bearing to beacon.

4th Observation

28°25'22"	oalt.	A.C. log sin 0.322417
66°46'56"	codeol.	
70°56'38"	oalt.	A.C. log sin 0.021477
<u>2)166°08'15"</u>		
83°04'28"	S	log sin 9.996820
66°46'56"		
<u>16°17'32"</u>	S-codeol.	log sin 9.447969
		<u>2)9.791703</u>
	cos $\frac{1}{2}$ A =	9.695851

$$\frac{1}{2} A = \frac{38^{\circ}06'53''}{2}$$

N. 76°13'45" E. true bearing to sun

152°28'30" angle sun to beacon

$$\frac{76^{\circ}13'45''}{2}$$

N. 76°14'44" W. True bearing to beacon.

THE UNIVERSITY OF CHICAGO
DIVISION OF THE PHYSICAL SCIENCES
DEPARTMENT OF PHYSICS

REPORT OF THE
COMMISSIONER OF THE
BUREAU OF THE CENSUS
ON THE
CENSUS OF 1900
POPULATION
AND
HABITATION

BY
J. EDWARD SMITH
CHIEF OF BUREAU

WASHINGTON
GOVERNMENT PRINTING OFFICE
1903

THE UNIVERSITY OF CHICAGO
DIVISION OF THE PHYSICAL SCIENCES
DEPARTMENT OF PHYSICS

REPORT OF THE
COMMISSIONER OF THE
BUREAU OF THE CENSUS
ON THE
CENSUS OF 1900
POPULATION
AND
HABITATION

BY
J. EDWARD SMITH
CHIEF OF BUREAU

Mean of

Observation taken at this point
June 28th, at 7 h 17 m P.M.
135° time
give course to beacon

N. 76°14'14.2" W.

Mean of

Observation taken at this point
June 29th at 7 h 25 m A.M.
135° time
give course to beacon

N. 76°14'14.5" W.

Course to beacon mean of
A.M. and P.M. observations

N. 76°14'14.3" W.

1944

1. The first part of the report is devoted to a description of the work done during the year. It is divided into two main sections: a general survey of the work and a detailed account of the results of the various experiments.

1945

2. The second part of the report is devoted to a description of the work done during the year. It is divided into two main sections: a general survey of the work and a detailed account of the results of the various experiments.

1946

1947

1948

FIELD TEST OF VERTICAL CIRCLE.

In order that the engineer may make proper reductions of astronomical altitude observations when unable to make compensating observations (southeasterly and southwesterly observations at approximately equal altitude), it is essential that he know the index error of the vertical circle of his transit throughout the range of vertical angles used in such observations. Normally this range is from 20° to 50°, with the telescope in direct and reversed positions.

There are three methods available for making this vertical circle test in the field:

1. By direct comparison with a transit with known vertical circle indications.
2. By meridian passage observations on a series of equatorial stars throughout this vertical angle range, at a station of known latitude, and comparing the observed vertical angles, corrected for refraction, with the computed true altitude of these stars.
3. By making a series of altitude observations of the sun or a star throughout this angular range, properly balanced by southeasterly and southwesterly observations, at a station of known latitude, and preferably where the meridian has been accurately determined. Then determine the error in the reduced azimuth of each observation, and divide this error by the coefficient taken from the diagram of errors in azimuth due to small errors in vertical angle, to get the indicated error of the vertical angle reading.

The following data are the results of a test of the vertical circle of Buff Transit No. 17993, by the last method, made on March 14 and April 9, 1946, at the G.L.O testing station No. 1, Washington, D. C., in latitude 38° 53' 30" N., and longitude 77° 03' W., orienting on the tip of the Washington Monument, bearing S. 54° 40' 25" E. Each observation in the test consisted of six readings, all with the telescope in the direct or reversed positions, three each on opposite limbs of the sun.

Transit: Buff No. 17993

TELESCOPE DIRECT.

Obs.	Date	Decl.	Vert. angle	Bearing of Monument		Hor. error	Coeff.	Vert. error
				A. M.	P. M.			
1	3/14/46	2°38'22"S.	19°15'30"	S.54°40'27"E.		+ 2"	1.02	- 2"
2	"	2°37'51"S.	24°59'15"	S.54°40'07"E.		- 18"	1.16	+ 16"
11	"	2°30'38"S.	24°35'30"	S.54°40'32"E.		+ 7	1.15	+ 7
Mean	"		24°47'22"	S.54°40'20"E.				+ 12
3	"	2°37'28"S.	28°52'50"	S.54°40'17"E.		+ 8"	1.32	+ 6"
10	"	2°30'57"S.	27°52'25"	S.54°41'02"E.		+ 37	1.26	+ 29
Mean	"		28°22'37"	S.54°40'40"E.				+ 17
4	"	2°36'39"S.	36°14'30"	S.54°39'17"E.		-1°08"	1.93	+ 35"
9	"	2°31'35"S.	34°11'45"	S.54°40'53"E.		+ 28	1.66	+ 17
Mean	"		35°28'07"	S.54°40'05"E.				+ 26
5	"	2°36'11"S.	40°15'20"	S.54°40'18"E.		- 7	2.44	+ 3
8	4/9/46	7°35'46"S.	39°59'40"	S.54°40'51"E.		+ 26	1.42	+ 18
Mean	"		40°07'30"	S.54°40'34"E.				+ 11
6	3/14/46	2°35'34"S.	44°11'40"	S.54°40'09"E.		+ 16	4.00	+ 4
7	"	2°33'09"S.	45°41'30"	S.54°40'42"E.		+ 17	4.95	+ 3
Mean	"		46°11'35"	S.54°40'25"E.				+ 3

Mean bearing of monument, telescope direct = S. 54° 40' 25" E.

1. The first part of the report deals with the general situation of the country and the progress of the work during the year.

2. The second part of the report deals with the results of the work during the year.

3. The third part of the report deals with the financial situation of the country.

4. The fourth part of the report deals with the social situation of the country.

5. The fifth part of the report deals with the economic situation of the country.

6. The sixth part of the report deals with the political situation of the country.

7. The seventh part of the report deals with the cultural situation of the country.

8. The eighth part of the report deals with the military situation of the country.

9. The ninth part of the report deals with the foreign relations of the country.

10. The tenth part of the report deals with the general conclusion of the work.

11. The eleventh part of the report deals with the general conclusion of the work.

12. The twelfth part of the report deals with the general conclusion of the work.

13. The thirteenth part of the report deals with the general conclusion of the work.

14. The fourteenth part of the report deals with the general conclusion of the work.

15. The fifteenth part of the report deals with the general conclusion of the work.

16. The sixteenth part of the report deals with the general conclusion of the work.

17. The seventeenth part of the report deals with the general conclusion of the work.

18. The eighteenth part of the report deals with the general conclusion of the work.

19. The nineteenth part of the report deals with the general conclusion of the work.

20. The twentieth part of the report deals with the general conclusion of the work.

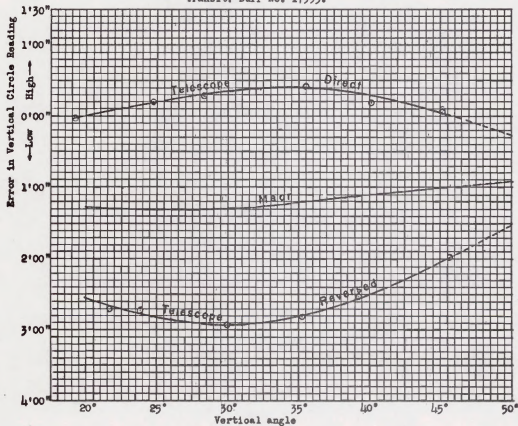
TELESCOPE REVERSED.

Obs.	Date	Decl.	Vert. angle	Bearing of Monument		Hor. error	Coeff.	Vert. error
				A. M.	P. M.			
1	3/14/46	2°38'15"S.	20°36'00"	S.54°43'27"E.		+3'02"	1.05	-2'53"
12	4/9/46	7 36 15 N.	22 47 20	S.54°38'06"E.		-2 19	0.92	-2 31
Mean			21 41 25	S.54°40'16"E.				-2 42
2	3/14/46	2°37'59"S.	23°27'05"	S.54°43'26"E.		+3'01"	1.12	-2'42"
11	4/3/46	7 36 03 N.	24 12 55	S.54°37'49"E.		-2'36	0.95	-2 44
Mean			23 50 00	S.54°40'37"E.				-2 43
3	3/14/46	2°37'23"S.	29°48'32"	S.54°44'40"E.		+4'15"	1.42	-3'00"
10	4/9/46	7 35 35 N.	30 02 00	S.54°37'24"E.		-3 01	1.05	-2 52
Mean			29 58 46	S.54°41'02"E.				-2 56
4	3/14/46	2°36'55"S.	34°18'45"	S.54°45'28"E.		+5'03"	1.68	-3'01"
9		2 31 49 S.	36 08 25	S.54°35'32"E.		-4 53	1.86	-2 38
Mean			35 13 35	S.54°40'30"E.				-2 49
5	"	2°36'09"S.	40°46'05"	S.54°46'09"E.		+5'44"	2.55	-2'15"
8		2 32 00 S.	37 42 30	S.54°34'41"E.		-5 44	2.04	-2 49
Mean			39 14 17	S.54°40'25"E.				-2 32
6	"	2°35'29"S.	45°05'10"	S.54°49'20"E.		+8'55"	4.50	-1'59"
7		2 33 14 S.	46°04'00"	S.54°30'17"E.		-10 08	5.10	-1 59
Mean			46 34 35	S.54°39'49"E.				-1 59

Mean bearing of monument, telescope reversed = S. 54° 40' 31" E.

Vertical Circle Indications.

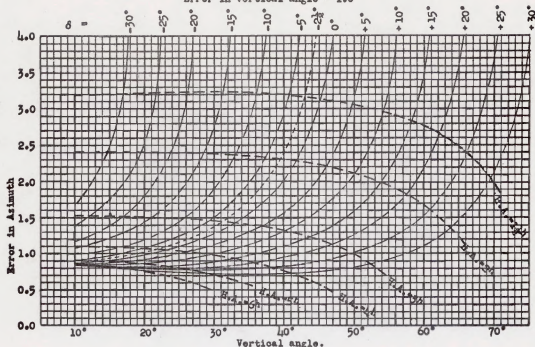
Transit Buff No. 17993.



the first of these is the fact that the
the second is the fact that the
the third is the fact that the
the fourth is the fact that the
the fifth is the fact that the
the sixth is the fact that the
the seventh is the fact that the
the eighth is the fact that the
the ninth is the fact that the
the tenth is the fact that the

the eleventh is the fact that the
the twelfth is the fact that the
the thirteenth is the fact that the
the fourteenth is the fact that the
the fifteenth is the fact that the
the sixteenth is the fact that the
the seventeenth is the fact that the
the eighteenth is the fact that the
the nineteenth is the fact that the
the twentieth is the fact that the
the twenty-first is the fact that the
the twenty-second is the fact that the
the twenty-third is the fact that the
the twenty-fourth is the fact that the
the twenty-fifth is the fact that the
the twenty-sixth is the fact that the
the twenty-seventh is the fact that the
the twenty-eighth is the fact that the
the twenty-ninth is the fact that the
the thirtieth is the fact that the

ERRORS IN AZIMUTH RESULTING FROM SMALL ERRORS IN VERTICAL ANGLE
 Computed for latitude 40° N.
 Error in vertical angle = 1.0



Vertical angle too large = Azimuth of sun or star too small.
 " " " small = " " " " " " " large.

SUMMARY

The ratio between errors in the reduced azimuth and errors in the vertical angle determination increases as the declination changes southward, and as the vertical angle increases and the hour angle decreases. For example; at vertical angle 30° and declination 10° N. an error of 1' in the vertical angle results in an error of 1' in the reduced azimuth, while at vertical angle 30° and declination 15° S. the same error in vertical angle results in an error of 2.72' (1' $43''$) in the reduced azimuth.

The precision of results obtained in single latitude observations and altitude observations for azimuth and time are dependent upon the accuracy of the vertical angle determination.

A series of altitude observations in the same quadrant may check within themselves and still be in error if a consistent error is included in the vertical angles (or in the latitude). It therefore becomes important that the vertical circle indications of a transit be well determined.

Such errors in azimuth determination resulting from errors in the vertical angle (as well as errors in latitude) can largely be eliminated by balancing southeasterly observations with southwesterly observations. However, because of the change in the "azimuth error-vertical angle error" ratio at different altitudes and declinations, proper balancing is obtained only when the altitudes and declinations are approximately equal.

Likewise, latitude observations should be balanced by north and south observations; that is, observations on Polaris (or other circumpolar stars) balanced with meridian observations on the sun or stars within the equatorial belt, and preferably at approximately equal altitudes.

Memorandum.

A graph, similar to the above, for latitude 50° , will show much larger errors in azimuth, for the identical vertical angles and declinations; smaller errors in latitudes less than 40° .

George W. Johnson,
 Assistant Cadastral Engineer,
 General Land Office,
 Washington, D. C.

G.W.J.

Example of direct altitude observation of the sun for azimuth, sun south declination:

Date: October 13, 1944.

Observer: Hugh B. Crawford

Instrument: Buff No. 17993

Test of vertical circle, January 5, 1945:

Telescope direct sights low at zero 09-00' 30"

Telescope reversed sights high at zero 0 05 00

Test of vertical circle, October 14, 1944, against known latitude:

Telescope direct reading reduced to the sun's center crossing the meridian gives plus 0° 00' 36" (reads high)

Telescope reversed reading reduced to the sun's center crossing the meridian gives minus 0° 03' 02" (reads low)

October 13, 1944, at a transit point, on a tract known as Outlet Lettered E, situated in the town of Walde, Russell County, Kansas, in the W. $\frac{1}{4}$ of SW. $\frac{1}{4}$, sec. 5, T. 11 S., R. 13 W., in latitude 39° 07' 24" N., and longitude 98° 47' 55" W., at 8:45 a.m., app. t., I make a series of three altitude observations upon the sun for azimuth, each with the telescope in direct and reversed positions, observing opposite limbs of the sun; setting first on the East edge of a stone post, 0.6 feet wide, 20.50 obs. E., reversing the telescope, and then reading the horizontal deflection angle SE. to the sun:

Observation.	Telescope.	sun.	App. time.	Observed Vertical Angle.	Corrected Vertical Angle.	Hor. Angle SE.
1st	Reversed	d	8h40m00s	24° 30' 00"	24° 33' 00"	55° 42' 00"
"	Direct	p	24 14 00	24 14 00	24 13 30	56 00 00
	Mean			24° 22' 00"	24° 23' 15"	55° 51' 00"
2nd	Direct	d	8h45m00s	24° 58' 00"	24° 57' 30"	55° 10' 00"
"	Reversed	p	24 37 00	24 37 00	24 40 00	55 26 00
	Mean			24° 47' 30"	24° 48' 45"	55° 18' 00"
3rd	Reversed	d	8h50m00s	25° 23' 00"	25° 26' 00"	54° 33' 00"
"	Direct	p	25 08 00	25 08 00	25 07 30	54 48 00
	Mean			25° 15' 30"	25° 16' 15"	54° 40' 30"

By 1st obs. E. edge of post bears N. 0° 03' 04" E.

" 2nd " " " " " " N. 0 03 18 E.

" 3rd " " " " " " N. 0 02 51 E.

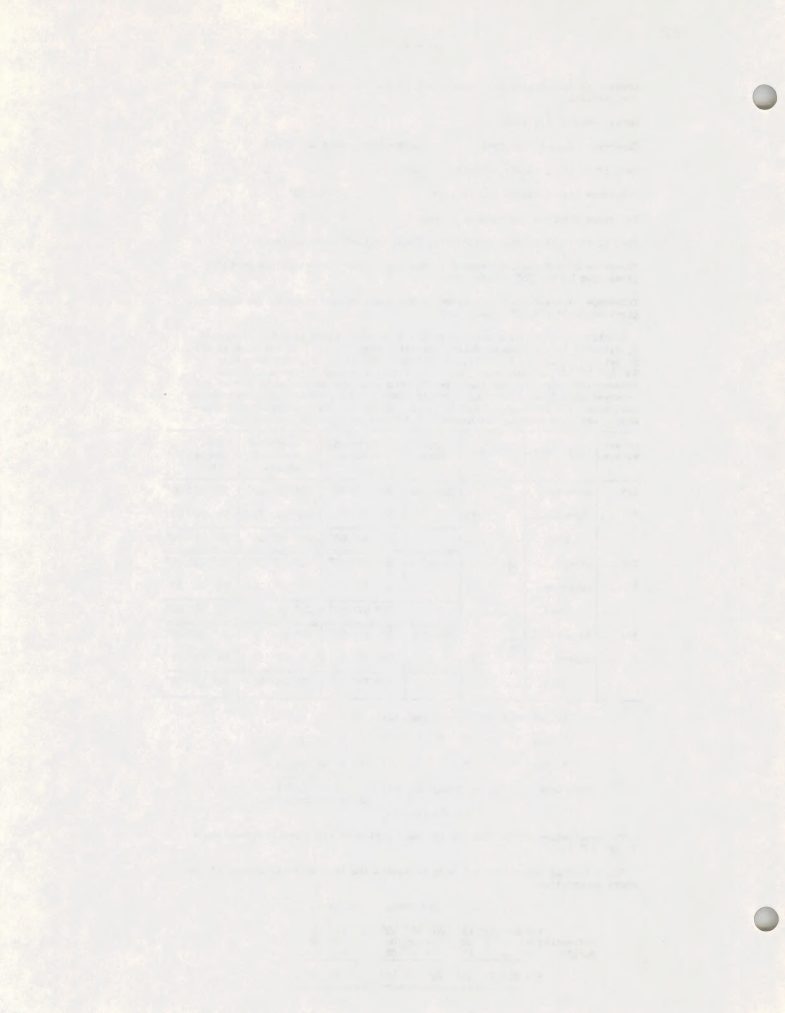
Mean true bearing of E. edge of post = N. 0° 03' 04" E.

Field record.

The declination of the sun for the mean period of the three observations = 7° 52' 40" S.

The following reductions are made to obtain the true vertical angles of the above observations:

	1st obsn.	2nd obsn.	3rd obsn.
$v =$	24° 23' 15"	24° 48' 45"	25° 16' 45"
Refraction =	- 2 07	- 2 04	- 2 02
Parallax =	+ .08	+ .08	+ .08
$h =$	<u>24° 21' 16"</u>	<u>24° 46' 49"</u>	<u>25° 14' 51"</u>



Reduction to Sun's Center.

Using vertical angle correction values
determined by test by G. W. Johnson.

Obsn.	Telescope.	Bearing of mark.	
1st.	Reversed	N. 0° 03' 19" E.	
	Direct	N. 0 03 03 E.	
	Mean	N. 0 03 11 E.	
2nd.	Direct	N. 0° 03' 49" E.	
	Reversed	N. 0 02 58 E.	
	Mean	N. 0 03 23 E.	
3rd.	Reversed	N. 0° 03' 48" E.	
	Direct	N. 0 02 05 E.	
	Mean	N. 0 02 56 E.	
		Mean of all	
		N. 0° 03' 10" E.	

Recapitulation.

Bearing of mark, using vertical angles
without eccentricity correction, mean = N. 0° 01' 25" E.
Bearing of mark, using vert. ang. eccen-
tricity corr. determined by meridian
observation of sun, mean = N. 0° 03' 04" E.
Bearing of mark, using vert. ang. eccen-
tricity corr. determined by test made
by G. W. Johnson, mean = N. 0° 03' 10" E.
Bearing of auxiliary mark by hour
angle obsn. of Polaris = N. 0° 01' 07" E.
Self. ang. to above mk. = 0 01 35
" N. 0° 02' 42" E.

THE HISTORY OF THE UNITED STATES OF AMERICA FROM 1789 TO 1876

CHAPTER	PAGE	CHAPTER	PAGE
I. THE FOUNDING OF THE NATION	1	XV. THE RECONSTRUCTION OF THE SOUTH	151
II. THE EARLY YEARS OF THE REPUBLIC	11	XVI. THE CIVIL WAR	201
III. THE GROWTH OF THE NATION	21	XVII. THE RECONSTRUCTION OF THE NORTH	291
IV. THE WESTERN EXPLORATION	31	XVIII. THE GROWTH OF THE NATION	381
V. THE FRONTIER MOVEMENT	41	XIX. THE RECONSTRUCTION OF THE SOUTH	471
VI. THE INDUSTRIAL REVOLUTION	51	XX. THE CIVIL WAR	561
VII. THE GROWTH OF THE NATION	61	XXI. THE RECONSTRUCTION OF THE NORTH	651
VIII. THE WESTERN EXPLORATION	71	XXII. THE GROWTH OF THE NATION	741
IX. THE FRONTIER MOVEMENT	81	XXIII. THE RECONSTRUCTION OF THE SOUTH	831
X. THE INDUSTRIAL REVOLUTION	91	XXIV. THE CIVIL WAR	921
XI. THE GROWTH OF THE NATION	101	XXV. THE RECONSTRUCTION OF THE NORTH	1011
XII. THE WESTERN EXPLORATION	111	XXVI. THE GROWTH OF THE NATION	1101
XIII. THE FRONTIER MOVEMENT	121	XXVII. THE RECONSTRUCTION OF THE SOUTH	1191
XIV. THE INDUSTRIAL REVOLUTION	131	XXVIII. THE CIVIL WAR	1281

THE HISTORY OF THE UNITED STATES OF AMERICA FROM 1789 TO 1876

CHAPTER I.	THE FOUNDING OF THE NATION
CHAPTER II.	THE EARLY YEARS OF THE REPUBLIC
CHAPTER III.	THE GROWTH OF THE NATION
CHAPTER IV.	THE WESTERN EXPLORATION
CHAPTER V.	THE FRONTIER MOVEMENT
CHAPTER VI.	THE INDUSTRIAL REVOLUTION
CHAPTER VII.	THE GROWTH OF THE NATION
CHAPTER VIII.	THE WESTERN EXPLORATION
CHAPTER IX.	THE FRONTIER MOVEMENT
CHAPTER X.	THE INDUSTRIAL REVOLUTION
CHAPTER XI.	THE GROWTH OF THE NATION
CHAPTER XII.	THE WESTERN EXPLORATION
CHAPTER XIII.	THE FRONTIER MOVEMENT
CHAPTER XIV.	THE INDUSTRIAL REVOLUTION
CHAPTER XV.	THE GROWTH OF THE NATION
CHAPTER XVI.	THE WESTERN EXPLORATION
CHAPTER XVII.	THE FRONTIER MOVEMENT
CHAPTER XVIII.	THE INDUSTRIAL REVOLUTION
CHAPTER XIX.	THE GROWTH OF THE NATION
CHAPTER XX.	THE WESTERN EXPLORATION
CHAPTER XXI.	THE FRONTIER MOVEMENT
CHAPTER XXII.	THE INDUSTRIAL REVOLUTION
CHAPTER XXIII.	THE GROWTH OF THE NATION
CHAPTER XXIV.	THE WESTERN EXPLORATION
CHAPTER XXV.	THE FRONTIER MOVEMENT
CHAPTER XXVI.	THE INDUSTRIAL REVOLUTION
CHAPTER XXVII.	THE GROWTH OF THE NATION
CHAPTER XXVIII.	THE WESTERN EXPLORATION
CHAPTER XXIX.	THE FRONTIER MOVEMENT
CHAPTER XXX.	THE INDUSTRIAL REVOLUTION

Date: August 14, 1945

Instrument: Surley No. 371540

Observer: Oscar B. Walsh
Recorder: Hugh B. Crawford

Example of direct altitude observations on two stars, one in southeast and one in southwest, for azimuth and time, using transit with eccentric vertical circle; telescope equipped with solar circle and double cross wires, spaced 40" apart.

Transcribed Field Notes.

August 14, 1945, at camp in the SE $\frac{1}{4}$ sec. 15, Township 40 North, Range 14 East, Fourth Principal Meridian, Wisconsin, in latitude 45° 56' 26" N., longitude 88° 43' W., elevation above sea level, approximately 650 ft., temperature 70° F., at 6^h 44^m 53^s p.m., Central Standard time, I make a series of observations on the star α Aquilae (Altair) for azimuth, making four observations, observing simultaneously the vertical angle to the star, and the horizontal angle to a stake, approximately 7 chs. south of my station.

Observation	Telescope	Central Standard time	Vertical angle	Horizontal angle mark to star
1	Direct	6 ^h 44 ^m 53 ^s	32° 15' 00"	66° 47' 30"
2	"	6 ^h 46 ^m 00 ^s	32° 28' 00"	66° 29' 00"
3	Reversed	6 ^h 46 ^m 00 ^s	32° 47' 00"	66° 04' 00"
4	"	6 ^h 49 ^m 05 ^s	32° 56' 00"	65° 51' 00"

By 1st. obsn., mark bears S. 00° 02' 02" E.
 " 2nd. " " " S. 00° 02' 22" E.
 " 3rd. " " " S. 00° 00' 26" E.
 " 4th. " " " S. 00° 00' 47" E.

Mean of southeast observations: S. 00° 01' 24" E.

August 16, 1945, at the same station, in temperature 70° F., at 8^h 27^m 26^s p.m., Central Standard time, I repeat the above observations, observing simultaneously the vertical angle to the star α Virginis (Spica) in the southwest, and the horizontal angle to the same mark, approximately 12 chs. south of my station.

Observation	Telescope	Central Standard time	Vertical angle	Horizontal angle mark to star
1	Direct	8 ^h 27 ^m 26 ^s	21° 37' 30"	45° 30' 00"
2	"	8 ^h 28 ^m 28 ^s	21° 27' 00"	45° 51' 00"
3	Reversed	8 ^h 32 ^m 54 ^s	20° 41' 00"	47° 13' 00"
4	"	8 ^h 38 ^m 17 ^s	19° 45' 00"	48° 50' 00"

By 1st. obsn., mark bears S. 00° 01' 24" W.
 " 2nd. " " " S. 00° 00' 19" E.
 " 3rd. " " " S. 00° 00' 09" E.
 " 4th. " " " S. 00° 00' 22" E.

Mean of southwest observations S. 00° 00' 09" W.

Mean of southeast observations S. 00° 01' 24" E.

Mean, true bearing of mark S. 00° 00' 37" E.

Memo.: Bearing of reference mark by hour angle observation on Polaris,
 Aug. 2nd, by Mr. Crawford (p. 3): S. 00° 00' 12" E.

Field Record

The above observations are reduced by the equation:

$$\cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h$$

1st. series, Altair in southeast.

Declination of the star α Aquilae (Altair), August 14, 1945... $8^{\circ} 43' 30''$ N.

Latitude $45^{\circ} 56' 26''$ N.

Longitude $88^{\circ} 43' 00''$ W.

Refraction coef. = $.99 \times .97 = .96$

1st. obsn. for azimuth.

$$\begin{aligned} \nabla & \dots\dots\dots = 32^{\circ} 15' 00'' \\ \text{Refraction } (91'' \times .96) & \dots\dots\dots 1' 27'' \\ h & \dots\dots\dots 32^{\circ} 13' 33'' \end{aligned}$$

$$\sin \delta \dots\dots\dots = .1516921$$

$$\cos \phi = .6954043$$

$$\cos h = .8459628$$

$$.5882862$$

$$.5882862$$

$$.2578542$$

$$\tan \phi = 1.0333525$$

$$\tan h = .6202624$$

$$.6513876$$

$$.2578542$$

$$\cos A = .3935334$$

$$A = 66^{\circ} 49' 32'' \text{ N.E.}$$

$$\text{Hor. ang.} = 66^{\circ} 47' 30''$$

By 1st. obsn., mark bears
" 2nd. " " "
" 3rd. " " "
" 4th. " " "

S. $00^{\circ} 02' 02''$ E.
S. $00^{\circ} 02' 22''$ E.
S. $00^{\circ} 00' 26''$ E.
S. $00^{\circ} 00' 47''$ E.

1st. obsn. for time.

$$\cos t = \frac{\sin h}{\cos \phi \cos \delta} - \tan \phi \tan \delta$$

$$\sin h \dots\dots\dots = .5332577$$

$$\cos \phi = .6954043$$

$$\cos \delta = .9884278$$

$$.6873569$$

$$.6873569$$

$$.7758090$$

$$\tan \phi = 1.0333525$$

$$\tan \delta = .1521681$$

$$.1505866$$

$$.7758090$$

$$\cos t = .6172221$$

$$t = 51^{\circ} 53' 11'' =$$

$$\text{Reduced to mean time hour angle} = 3^{\text{h}} 27^{\text{m}} 32^{\text{s}}$$

$$\text{Mean time hour angle} = 3^{\text{h}} 26^{\text{m}} 58^{\text{s}}$$

$$\text{Star's transit p.m.} = 10^{\text{h}} 15^{\text{m}} 20^{\text{s}}$$

$$\text{Correct l.m.t. of obsn.} = 6^{\text{h}} 48^{\text{m}} 22^{\text{s}}$$

$$90^{\text{th}} \text{ meridian time } (-5^{\text{m}} 08^{\text{s}}) = 6^{\text{h}} 43^{\text{m}} 14^{\text{s}}$$

$$\text{Watch time of observation} = 6^{\text{h}} 44^{\text{m}} 53^{\text{s}}$$

$$\text{Watch fast} = 1^{\text{m}} 39^{\text{s}}$$

l.m.t.
p.m.
p.m.
p.m.

2nd. series, Spica in southwest, August 16, 1945.

Declination of the star α Virginis (Spica) in southwest, .. = $10^{\circ} 52' 30''$

By 1st. obsn., mark bears
" 2nd. " " "
" 3rd. " " "
" 4th. " " "

S. $00^{\circ} 01' 24''$ W.
S. $00^{\circ} 00' 19''$ E.
S. $00^{\circ} 00' 09''$ E.
S. $00^{\circ} 00' 22''$ E.

Example of hour angle observation of Polaris, observing program "b":

Date: August 2, 1945.

Observer: Hugh B. Crawford

Instrument: Gurley No. 371540

Field record.

Hour angle observation of Polaris:

Telescope.	Horizontal angle from post to Polaris.	Watch time.
Direct----	$0^{\circ} 39' 00''$	$7^h 51^m 20^s$
Reversed----		$7 52 41$
Direct----		$7 54 00$
Reversed----	$2^{\circ} 33' 30''$	$7 55 11$
Mean	$0^{\circ} 38' 22''$	$7^h 53^m 18^s$
Watch fast of l.m.t.-----	-1 5 17	
L.M.T. of obsn. Aug. 2, 1945	= $6^h 48^m 01^s$ p.m.	
Gr. U. C. of Polaris, Aug. 3, 1945-----	= $5^h 0.5^m$ a.m.	
Red. to long. $88^{\circ} 43' W.$ -----	= - 1.0	
	$4^h 59.5^m$ a.m.	
L.M.T. of U.C.-----	= 12	
L.M.T. of obsn. Aug. 2	= $6 48.0$ p.m.	
Hour angle, east	= $10^h 11.5^m$	
Declination of Polaris = $+88^{\circ} 59' 59.72''$		

August 2, 1945, at a transit point in camp, in the SE. $\frac{1}{2}$ SE. $\frac{1}{2}$ sec. 15, T. 40 N., R. 14 E., in approximate latitude $45^{\circ} 56' 26''$ N. and longitude $88^{\circ} 43' 00''$ W., I find my watch is $18^m 5^s 17^s$ fast of l.m.t. ($\frac{1}{4}$ Gen. Stan. War T.) by an altitude observation of the sun for time.

At the same station at $6^h 48^m 01^s$ p.m., l.m.t., I make an hour angle observation of Polaris, east of the meridian, two each with the telescope in direct and reversed position, pointing at a post, south, 7.30 obs. dist., transiting the telescope and reading the horizontal deflection angle east to Polaris.

Watch time of obsn. = $7^h 53^m 18^s$ p.m.

Mean horizontal angle from Polaris to post = $0^{\circ} 38' 22''$

Azimuth of Polaris by inter. = $0^{\circ} 38' 10''$

Azimuth of Polaris by formula = $0^{\circ} 38' 11''$

S. E.

True bearing of post = $0^{\circ} 00' 11''$ N. 12 W.

Mean time hour angle.	Azimuth of Polaris.			Correction additive for de- clination +89°00'00"
	Mean declination +89° 00' 20"			
	Latitude			
	44°	45° 56.4'	46°	
10 8.3	37'.7	38' 58"	39'.0	0'.2
11.5		37 58		0.2
18.3	34.5	35 40	35.7	0.2

Azimuth of Polaris = $0^{\circ} 38' 10''$

Observation for time.	Telescope.	Sun.	Watch time. p.m.	Vertical angle.
Direct	\odot		$7^h 09^m 11^s$	$13^{\circ} 06' 00''$

Apparent time = $5^h 57^m 48^s$ p.m.

plus squa. t. = $+ 6 6$

L.M.T. = $6^h 04^m 54^s$

Watch time = $7 09 11$

Watch fast = $1^h 5^m 17^s$

Decl. of sun for time observation = $17^{\circ} 40' 10'' N.$

SUN AND STAR OBSERVATIONS FOR LATITUDE, TIME, AND AZIMUTH

Station: Casa Ybel Hotel, on the south shore of Sanibel Island, Fla.

Latitude: Scaled from Coast Survey Chart 26° 25' 20" N.
Longitude: " " " " " 82° 04' 15" W.

Observer, Recorder, and Timer, Jos. C. Thoma

Instrument: Gurley solar transit No. 371536,
all circles reading to single
minutes.

I set a stake approximately 8 chains northerly from my station for a reference line. Due to the absence of assistants, I did not set the stake exactly on my solar meridian.

March 6, 1945: At 3h20m p.m., app.t., I set off 26° 25' N. on the lat. arc, 5° 32' S. on the decl. arc, and determine a meridian with the solar and find the flag bears N. 0° 02' 30" E.

Polaris Observation for azimuth and latitude

March 6, 1945:

	Watch time	Vert. Ang.	Hor. Ang.
Tel. Dir.	7 ^h 49 ^m 45 ^s p.m.	27° 01' 00"	0° 57' 00" W.
Tel. Rev.	7 56 00 p.m.	27 00 00	0 58 00 W.
Means	7 52 52 p.m.	27 00 30	0 57 30 W.
Watch fast 1 m.t.	1 25 05		
L.m.t. of obsn.	6 27 47 p.m.		

L.M.T. U.C. Pol. March 6	2 ^h 48.9 ^m p.m.	W. sz. of Pol.	0° 54' 50"
Red. for long.	- .9	Ang. W., flag to star	0° 57' 30"
L.m.t. of obsn.	2 48.0 p.m.	Flag bears N.	0° 02' 40" E.
M.t.h.a. of Pol.	3 39.8		

The above azimuth of Polaris was obtained by interpolating the tables in the Ephemeris. The following azimuth was obtained by the reduction of the well-known formulae; using latitude as obtained from a noon observation of the sun on the following day.

M.t. h.a. of Pol.	3 ^h 39 ^m 48 ^s	t = 55° 06' 00"
Sid. red.	+ 26	φ = 26 24 30
Sidereal h. a.	3 40 24	δ = 89 00 23

Nat. Sin t =	0.82015	Nat. Sid. φ = 0.44477
" Cos φ =	0.89565	" cos t = 0.57215
" Tan δ =	57.65850	0.25048
	51.64184	
	0.25448	
	51.38736	
	0.61597	= nat. tan. A. A = 0° 54' 50" W.

THE UNIVERSITY OF CHICAGO PRESS

1910

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS

Latitude as above, using tables:

$$\begin{aligned}
 \text{M.t.h.a. Polaris} &= 3^{\text{h}} 39.6^{\text{m}} & \delta &= 89^{\circ} 00' 23'' \\
 \text{Mean observed vertical angle} &= 27^{\circ} 00' 30'' \\
 \text{Correction for refraction} &= \underline{-1 \ 53} \\
 h &= 26^{\circ} 58' 37'' \\
 \text{Primary adj. to elev. of} & & & \\
 \text{pole (Polaris above pole)} &= -33 \ 46 \\
 \text{Supplemental correction} &= \underline{-11} \\
 \varphi &= 26^{\circ} 24' 40'' \text{ N.}
 \end{aligned}$$

Latitude as above, using formulae:

$$\begin{aligned}
 \cos(\varphi - \alpha) &= \frac{\sin \alpha \sin h}{\sin \delta} \\
 \text{Sidereal h. a.} &= 3^{\text{h}} 40^{\text{m}} 24^{\text{s}}, \quad t = 55^{\circ} 06' 00'' \\
 \text{Nat tan } \alpha &= \frac{\text{nat tan } \delta (57.65850)}{\text{nat cos } t (0.57215)} = 100.77514, \quad \alpha = 89^{\circ} 25' 53'' \\
 \cos(\varphi - \alpha) &= \frac{\sin \alpha (.9999507) \times \sin h (.4536319)}{\sin \delta (.9998496)} = .4536777 \\
 (\varphi - \alpha) &= 63^{\circ} 01' 12'' \\
 \alpha &= \underline{89 \ 25 \ 53} \\
 \varphi &= 26^{\circ} 24' 41'' \text{ N.}
 \end{aligned}$$

Moon Observation on the Sun for Latitude and Time

March 7, 1945.

	Watch time	Vert. Angle	
Tel. Dir.	1 ^h 35 ^m 10 ^s p.m.	58° 07' 00"	
Tel. Rev.	1 37 20 p.m.	58 29 00	
Means	1 36 15 p.m.	58° 23' 00"	
		<u>35</u>	Ref.
		<u>05</u>	Par.
		58° 22' 20" h	
Apparent noon	12 ^h 00 ^m 00 ^s	90° 00' 00"	
Equation of time	11 10	h = 58 22 30	
L.m.t. of app. noon	12 11 10 p.m.	<u>31 27 30</u>	
Watch time of app. noon	1 36 15 p.m.	$\delta = 5 \ 12 \ 56 \ \text{S.}$	
Watch fast l.m.t.	1 25 05	$\varphi = 26^{\circ} 24' 34'' \text{ N.}$	

THE UNIVERSITY OF CHICAGO

THE DEPARTMENT OF MATHEMATICS

THE UNIVERSITY OF CHICAGO

CHICAGO, ILL.

THE UNIVERSITY OF CHICAGO

CHICAGO, ILL.

THE UNIVERSITY OF CHICAGO

CHICAGO, ILL.

THE UNIVERSITY OF CHICAGO

CHICAGO, ILL.

THE UNIVERSITY OF CHICAGO

CHICAGO, ILL.

THE UNIVERSITY OF CHICAGO

CHICAGO, ILL.

CHICAGO, ILL.

THE UNIVERSITY OF CHICAGO

CHICAGO, ILL.

CHICAGO, ILL.

CHICAGO, ILL.

CHICAGO, ILL.

CHICAGO, ILL.

CHICAGO, ILL.

CHICAGO, ILL.

CHICAGO, ILL.

CHICAGO, ILL.

CHICAGO, ILL.

Observing the Transit of β Orionis (Rigel), No. 7/11, for latitude and time.

March 7, 1945 Mag. 0.3 $\delta = 8^{\circ} 16'$ long. $82^{\circ} 04' 15''$ W.

Watch time of obsn. $7^h 35^m 40^s$ p.m.

Observed vert. ang. $55^{\circ} 18' 30''$
 Ref. $- 40$
 h $55^{\circ} 17' 50''$

Gr.m.t. of Transit, Mar. 1	$6^h 35.1^m$ p.m.		$90^{\circ} 00' 00''$
Red. to Mar. 7	$- 23.6$		$h - 55^{\circ} 17' 50''$
Gr.m.t. of transit Mar. 7	$6^h 11.5^m$ p.m.		$34^{\circ} 42' 10''$
Red. for long.	$.9$		$\delta 8^{\circ} 16' 00''$ S.
L.m.t. transit Mar. 7	$6^h 10.6^m$ p.m.		$\varphi 26^{\circ} 26' 10''$ N.
L.m.t. transit Mar. 7	$6^h 10^m 36^s$ p.m.		
Watch t. " " 7	$7^h 35^m 40^s$ p.m.		
Watch fast l.m.t.	$1^m 25^s 04^s$		

Recapitulation

Azimuth of Polaris:

By interpolating the tables	$0^{\circ} 54' 50''$ W.	Bearing	N. $0^{\circ} 02' 40''$ E.
By reducing the formula	$0^{\circ} 54' 50''$ W.		N. $0^{\circ} 02' 40''$ E.
By the solar transit			N. $0^{\circ} 02' 30''$ E.

Time

By obsn. on the sun	$1^h 25^m 05^s$	Watch fast l.m.t.
By obsn. on Rigel	$1^h 25^m 04^s$	" " "

Latitude:

By obsn. on Polaris, using tables	$26^{\circ} 24' 40''$ N.
By " " " formula	$26^{\circ} 24' 41''$
By noon obsn. on the sun	$26^{\circ} 24' 34''$
By obsn. on Rigel	$26^{\circ} 26' 10''$
By scale U.S.C. & G.S. chart	$26^{\circ} 25' 20''$

Balancing latitude:

Polaris (north)	$26^{\circ} 24' 40''$ N.
Sun (south)	$26^{\circ} 24' 34''$ N.
Rigel (south)	$26^{\circ} 26' 10''$
Mean	$26^{\circ} 25' 22''$ N.
Balanced latitude, mean	$26^{\circ} 25' 01''$ N.
U. S. C. & G. S. chart	$26^{\circ} 25' 20''$ N.

Date: June 15, 1945.

Instrument: Gurley No. 391237.

Observer: George W. Johnson.

Recorder: Oscar E. Walsh.

Example of direct altitude observation of the sun for azimuth, using transit equipped with solar circle:

Transcribed field notes.

June 15, 1945, at observation station No. 1, a cross in the sidewalk on the south side of C Street, opposite the south entrance to the Interior Building, Washington, D. C., in latitude $38^{\circ} 53' 30''$ N., and longitude $77^{\circ} 02' 11''$ W., elevation above sea level 10 ft., temperature 70° F., at $8^h 15^m$ a.m., apparent time, I make a series of altitude observations of the sun for azimuth, making six observations, three each with the telescope in direct and reversed positions, observing simultaneously the vertical angle of the sun's center and the horizontal angle from the tip of the Washington Monument, approximately 40 obs. southeasterly, to the left to the sun:

Observation.	Telescope.	Apparent time.	Vertical angle.	Horizontal angle, monument to sun.
1	Direct	$8^h 13^m 25^s$	$39^{\circ} 57' 00''$	$34^{\circ} 38' 00''$
2	"		$40^{\circ} 02' 00''$	$34^{\circ} 33' 00''$
3	"		$40^{\circ} 07' 00''$	$34^{\circ} 29' 00''$
4	Reversed		$40^{\circ} 20' 30''$	$34^{\circ} 18' 00''$
5	"		$40^{\circ} 25' 30''$	$34^{\circ} 14' 00''$
6	"	$8^h 16^m 25^s$	$40^{\circ} 32' 00''$	$34^{\circ} 09' 00''$
Mean		$8^h 14^m 55^s$		

By 1st obsn. monument bears S. $54^{\circ} 40' 06''$ E.
 " 2nd " " " S. $54^{\circ} 41' 01''$ E.
 " 3rd " " " S. $54^{\circ} 40' 56''$ E.
 " 4th " " " S. $54^{\circ} 40' 50''$ E.
 " 5th " " " S. $54^{\circ} 40' 43''$ E.
 " 6th " " " S. $54^{\circ} 40' 22''$ E.

Mean of a.m. obsns. S. $54^{\circ} 40' 40''$ E.

June 20, 1945, at the same station, in temperature 70° F., at $3^h 42^m$ p.m., apparent time, I repeat the above observation, observing the horizontal angle from the tip of the Washington Monument to the right to the sun:

Observation.	Telescope.	Apparent time.	Vertical angle.	Horizontal angle, monument to sun.
1	Direct	$3^h 42^m 30^s$	$40^{\circ} 59' 00''$	$113^{\circ} 20' 30''$
2	"		$40^{\circ} 52' 30''$	$113^{\circ} 26' 00''$
3	"		$40^{\circ} 45' 00''$	$113^{\circ} 32' 00''$
4	Reversed		$40^{\circ} 13' 00''$	$113^{\circ} 57' 00''$
5	"		$40^{\circ} 03' 30''$	$114^{\circ} 05' 00''$
6	"	$3^h 50^m 25^s$	$39^{\circ} 27' 00''$	$114^{\circ} 34' 00''$
Mean		$3^h 46^m 27^s$		

By 1st obsn. monument bears S. $54^{\circ} 41' 09''$ E.
 " 2nd " " " S. $54^{\circ} 41' 17''$ E.
 " 3rd " " " S. $54^{\circ} 41' 05''$ E.
 " 4th " " " S. $54^{\circ} 39' 48''$ E.
 " 5th " " " S. $54^{\circ} 41' 03''$ E.
 " 6th " " " S. $54^{\circ} 39' 24''$ E.

Mean of p.m. obsns. S. $54^{\circ} 40' 40''$ E.

Mean of a.m. obsns. S. $54^{\circ} 40' 40''$ E.

Mean, true bearing
 of monument S. $54^{\circ} 40' 40''$ E.

Footnote

Observation No. 6, p.m., delayed by a passing cloud.

Memo: Accepted bearing of monument = S. $54^{\circ} 40' 25''$ E.

Field record.

The above observations are reduced by the equation:

$$\cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h.$$

1st series, a.m. observations:

Sum's declination, Gr. app. noon, June 15, 1945 $23^{\circ} 18' 35''$ N.
Red. to long. $77^{\circ} 02' W.$, and $8^h 14^m 55^s$ a.m., $1.38^h \times 6.5''$ $9''$ N.

Sum's declination for mean time of observations, δ $23^{\circ} 18' 14''$ N.

Latitude, $\phi = 38^{\circ} 53' 30''$ N. Refraction coef. = $1.01 \times .96 = .97$

1st obsn:

$$\begin{aligned} V & \dots\dots\dots = 39^{\circ} 57' 00'' \\ \text{Refraction } (69'' \times .97 = 67'') & \dots\dots\dots = 1 \quad 07 \\ \text{Parallax} & \dots\dots\dots = 7 \\ h & \dots\dots\dots = 39^{\circ} 56' 00'' \end{aligned}$$

$$\begin{array}{rcl} \sin \delta & \dots\dots\dots & = .395741 \\ \cos \phi & = .778335 & \tan \phi = .806658 \\ \cos h & = .776792 & \tan h = .837119 \\ \hline & .596821 & .596821 \\ & & .675269 \\ & & \hline & & .663082 \end{array}$$

$$\begin{aligned} \cos A & = .012187 (-) \\ A & = 89^{\circ} 18' 06'' \text{ N.} \\ \text{Hor. ang.} & = 34 \quad 38 \quad 00 \end{aligned}$$

By 1st obsn. monument bears	S. $54^{\circ} 40' 06''$ E.
" 2nd " " "	S. $54^{\circ} 41' 01''$ E.
" 3rd " " "	S. $54^{\circ} 40' 55''$ E.
" 4th " " "	S. $54^{\circ} 40' 50''$ E.
" 5th " " "	S. $54^{\circ} 40' 43''$ E.
" 6th " " "	S. $54^{\circ} 40' 22''$ E.

2nd series, p.m. observations:

Sum's declination, Gr. app. noon, June 20, 1945 $23^{\circ} 26' 25''$ N.
Red. to long. $77^{\circ} 02' W.$, and $3^h 46^m 27^s$ p.m., $8.9^h \times 1.3''$ $12''$ N.

Sum's declination for mean time of observations, δ $23^{\circ} 26' 37''$ N.

Refraction coef. = $1.01 \times .96 = .97$

By 1st obsn. monument bears	S. $54^{\circ} 41' 09''$ E.
" 2nd " " "	S. $54^{\circ} 41' 17''$ E.
" 3rd " " "	S. $54^{\circ} 41' 05''$ E.
" 4th " " "	S. $54^{\circ} 39' 48''$ E.
" 5th " " "	S. $54^{\circ} 41' 03''$ E.
" 6th " " "	S. $54^{\circ} 39' 24''$ E.

The Solar Circle.



The reticle of the transit telescope has the above design, with specifications as follows: Double cross wire at left and bottom (direct position of telescope), spaced $40''$; solar circle, radius $15' 45''$; stadia ratio 1:132 horizontal and vertical.

10/10/1944

Received from the Hon. J. H. ...

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

10/10/1944

Date, June 15, 1945

Instrument: Curley No. 371540

Observer: Oscar B. Walsh
Recorder: George W. Johnson

Example of direct altitude observation of the sun for azimuth, using transit with eocentric vertical circle; telescope equipped with solar circle.

Transcribed field notes.

June 15, 1945, at observation station No. 1, a cross in the sidewalk on the south side of C Street, opposite the south entrance of the Interior Building, Washington D.C., in latitude $38^{\circ} 53' 30''$ N., and longitude $77^{\circ} 02' 11''$ W., elevation above sea level, 10 ft., temperature 70° F., at $7^h 50^m 15^s$ a.m., apparent time, I make a series of observations on the sun for azimuth, making six observations, observing simultaneously the vertical angle to the sun's center and the horizontal angle from the tip of the Washington Monument, approximately 40 obs. southeasterly, to the left to the sun.

Observation	Telescope	Apparent time	Vertical angle	Horizontal angle monument to sun.
1	Direct	$7^h 48^m 00^s$	$33^{\circ} 14' 00''$	$39^{\circ} 52' 00''$
2	"	"	$33^{\circ} 24' 00''$	$39^{\circ} 45' 00''$
3	"	"	$33^{\circ} 30' 00''$	$39^{\circ} 41' 00''$
4	Reversed	"	$33^{\circ} 57' 00''$	$39^{\circ} 20' 30''$
5	"	"	$34^{\circ} 05' 00''$	$39^{\circ} 14' 30''$
6	"	$7^h 53^m 30^s$	$34^{\circ} 12' 00''$	$39^{\circ} 08' 00''$
Mean		$7^h 50^m 30^s$		

By 1st. obsn., monument bears S. $54^{\circ} 41' 55''$ E.
 " 2nd. " " " S. $54^{\circ} 41' 18''$ E.
 " 3rd. " " " S. $54^{\circ} 40' 47''$ E.
 " 4th. " " " S. $54^{\circ} 40' 45''$ E.
 " 5th. " " " S. $54^{\circ} 40' 39''$ E.
 " 6th. " " " S. $54^{\circ} 41' 50''$ E.

Mean of a.m. observations ... S. $54^{\circ} 41' 12''$ E.

June 20, 1945, at the same station, in temperature 70° F., at $4^h 28^m 30^s$ p.m., apparent time, I repeat the above observations, observing the horizontal angle from the tip of the Washington Monument to the right to the sun.

Observation	Telescope	Apparent time	Vertical angle	Horizontal angle monument to sun.
1	Direct	$4^h 26^m 00^s$	$34^{\circ} 42' 30''$	$148^{\circ} 17' 00''$
2	"	"	$34^{\circ} 35' 00''$	$148^{\circ} 23' 00''$
3	"	"	$34^{\circ} 23' 00''$	$148^{\circ} 31' 00''$
4	Reversed	"	$33^{\circ} 57' 00''$	$148^{\circ} 51' 30''$
5	"	"	$33^{\circ} 46' 00''$	$149^{\circ} 00' 30''$
6	"	$4^h 31^m 30^s$	$33^{\circ} 33' 30''$	$149^{\circ} 09' 30''$
Mean		$4^h 28^m 30^s$		

By 1st. obsn., monument bears S. $54^{\circ} 39' 07''$ E.
 " 2nd. " " " S. $54^{\circ} 39' 28''$ E.
 " 3rd. " " " S. $54^{\circ} 38' 13''$ E.
 " 4th. " " " S. $54^{\circ} 38' 55''$ E.
 " 5th. " " " S. $54^{\circ} 39' 32''$ E.
 " 6th. " " " S. $54^{\circ} 39' 06''$ E.

Mean of p.m. observations S. $54^{\circ} 39' 03''$ E.

Mean of a.m. observations S. $54^{\circ} 41' 12''$ E.

Mean, true bearing
 of monument S. $54^{\circ} 40' 08''$ E.

Memo:

Accepted bearing of monument = S. $54^{\circ} 40' 25''$ E.

1. The first part of the report is a general introduction to the subject of the study.

2. The second part of the report is a detailed description of the methods used in the study.

3. The third part of the report is a presentation of the results of the study.

4. The fourth part of the report is a discussion of the results and their implications.

5. The fifth part of the report is a conclusion and a list of references.

Year	1980	1981	1982	1983	1984
Population	100	105	110	115	120
Income	100	105	110	115	120
Expenditure	100	105	110	115	120
Balance	0	0	0	0	0

6. The sixth part of the report is a summary of the findings and a list of references.

7. The seventh part of the report is a conclusion and a list of references.

8. The eighth part of the report is a conclusion and a list of references.

9. The ninth part of the report is a conclusion and a list of references.

10. The tenth part of the report is a conclusion and a list of references.

Year	1980	1981	1982	1983	1984
Population	100	105	110	115	120
Income	100	105	110	115	120
Expenditure	100	105	110	115	120
Balance	0	0	0	0	0

11. The eleventh part of the report is a conclusion and a list of references.

12. The twelfth part of the report is a conclusion and a list of references.

13. The thirteenth part of the report is a conclusion and a list of references.

14. The fourteenth part of the report is a conclusion and a list of references.

15. The fifteenth part of the report is a conclusion and a list of references.

Example of one complete and well-balanced stellar observing program:

- (1) The meridian passage of one star for time and latitude;
- (2) Polaris for azimuth and latitude; and,
- (3) Two well-placed stars in the equatorial belt, one easterly and one westerly, both for time and azimuth.

May 31, 1945

Instrument: Buff No. 24,847
General Land Office solar transit.

Observations by: Jos. C. Thoma, Cadastral Engineer.
Recording by: Arthur D. Kidder, District Cadastral Engineer;
watch reading approximate local mean time.

May 31, 1945, at the testing station, "Troy Cabin", situated on State Highway No. 2, 6 miles east of Troy, New York, and $\frac{1}{2}$ mile east of the Village of Eagle Mills; in latitude $42^{\circ}14'03''$ N., and longitude $73^{\circ}35'15''$ W.; these values as scaled from the U. S. Geological Survey topographic map, "Troy" quadrangle.

I prepare for one complete stellar observing program. The horizontal angles were turned from a temporary meridian marker, placed at a distance of 24.08 chains north. The mean of a number of previous observations for azimuth indicated that the temporary marker had a bearing of $N.00^{\circ}00'50''$ E. By observation on the sun at apparent noon today my watch was found to be $0^m 24^s$ slow of local mean time.

The following observing program was carried through prior to setting a permanent marker in the true meridian:

For finding position.		Approx. Direction	Vertical
Star.		l.m.t., of sight.	Angle.
		p.m.	
No. 19/35 α Bootis (Aroturus) 0.2 $\delta = +19^{\circ}28'06''$	5 ^h 16 ^m	S.88°27'E.	31°07'
No. 13/20 β Geminorum (Pollux) 1.2 $\delta = +28^{\circ}09'42''$	7 18.5	N.84°20'W.	37°39'
No. 4/6 α Urs.Min. (Polaris) 2.2 $\delta = +89^{\circ}00'00''$	7 30 Sunset	N.00°32'W.	41°48'
No. 17/33 α Virginis (Spica) 1.2 $\delta = -10^{\circ}52'36''$	8 45.6	South	36°23'

1. The first part of the report is a summary of the work done during the year.

- (a) The first part of the report is a summary of the work done during the year.
- (b) The second part of the report is a summary of the work done during the year.
- (c) The third part of the report is a summary of the work done during the year.

2. The second part of the report is a summary of the work done during the year.

3. The third part of the report is a summary of the work done during the year.

4. The fourth part of the report is a summary of the work done during the year.

5. The fifth part of the report is a summary of the work done during the year.

6. The sixth part of the report is a summary of the work done during the year.

7. The seventh part of the report is a summary of the work done during the year.

8. The eighth part of the report is a summary of the work done during the year.

9. The ninth part of the report is a summary of the work done during the year.

10. The tenth part of the report is a summary of the work done during the year.

11. The eleventh part of the report is a summary of the work done during the year.

12. The twelfth part of the report is a summary of the work done during the year.

13. The thirteenth part of the report is a summary of the work done during the year.

14. The fourteenth part of the report is a summary of the work done during the year.

15. The fifteenth part of the report is a summary of the work done during the year.

16. The sixteenth part of the report is a summary of the work done during the year.

17. The seventeenth part of the report is a summary of the work done during the year.

18. The eighteenth part of the report is a summary of the work done during the year.

19. The nineteenth part of the report is a summary of the work done during the year.

20. The twentieth part of the report is a summary of the work done during the year.

21. The twenty-first part of the report is a summary of the work done during the year.

22. The twenty-second part of the report is a summary of the work done during the year.

23. The twenty-third part of the report is a summary of the work done during the year.

24. The twenty-fourth part of the report is a summary of the work done during the year.

25. The twenty-fifth part of the report is a summary of the work done during the year.

Summary of all results.

	Time. Watch slow of l.m.t.	Latitude.	Asimuth. Indicated bearing of reference mark.
1st equatorial star, SE.	0 ^m 23 ^s		N.0°00'16"E.
2nd " " NW.	0 28		N.0 01 18 E.
Mean			N.0°00'147"E.
Polaris		42°13'14"	N.0 00 57 E.
3rd equatorial star at meridian passage	0 30	42 44 27	
Mean of all	0 ^m 27 ^s	42°14'05"	N.0°00'52"E.
U.S. Geol. Sur. topographic map:		42°14'03"	

1st Star: No. 19/35; α Bootis (Areturus); $\delta = +19^{\circ}28'06''$;
 meridian passage = 9^h 36^m.3 p.m., l.m.t., May 31, 1945; for time and
 azimuth.

Tel.	Watch time p.m.	Hor. Ang.	Observed Vert. Ang.
Dir.	5 ^h 19 ^m 05 ^s	92°07'30"	31°14'00"
Rev.	5 23 17	92 52 30	32 29 00
"	5 25 15	93 13 00	32 51 30
Dir.	5 28 17	93 45 00	33 26 00
Mean	5 ^h 23 ^m 58 ^s	92°59'30"	$\nu = 32^{\circ}37'37''$
			Refraction, $r = -1^{\circ}30'$
			$h = 32^{\circ}36'07''$

8.87°00'14"E. = Reduced azimuth of star.
 179°59'44"

N.00°00'16"E. = Indicated bearing of reference mark.

0^h36^m18^s

= Mer. pass. of star, p.m., l.m.t.

4 11 57

= Reduced mean time hour angle.

5^h 24^m 21^s

5^h 24^m 21^s

= Local mean time of observation.

0^m 23^s

= Watch slow of local mean time.

Apparent noon

12^h 00^m 00^s

Equation of time, subtractive

- 2 29

Local mean time of apparent noon

11 57 31

Watch time of sun's meridian passage

11 57 07

Watch slow of local mean time

24^s

1st Star: No. 19/35:

Star's transit, May 16, meridian of Greenwich = $10^h 36.1^m$ p.m.
 Reduction to " 31 = - 59.0
 " long. $73^\circ 35' 15''$ = - 0.8

Meridian passage of star, l.m.t. = $9^h 36.3^m$ p.m.

$\phi = 42^\circ 44' 03''$ $\delta = +19^\circ 28' 06''$ $h = 32^\circ 36' 07''$

$$\cos t = \frac{\sin h}{\cos \phi \cos \delta} - \tan \phi \tan \delta \quad \cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h$$

log	cos	sin	tan	cos	sin	tan
h =		9.731427		9.925536		9.805891
$\phi =$	9.865998		9.965615	9.865998		9.965615
$\delta =$	9.974431		9.548385		9.522817	
	9.840429	9.840429	9.514000	9.791534	9.791534	9.771306
		9.890998			9.731283	
nat		.77803	.32659		.53862	.59089
		.32659			.53862	.53862
$\cos t =$		.451144 (+)		$\cos A =$		.05227 (-)

$t = 63^\circ 09' 50''$

$A = 8.87^\circ 00' 14''$

$4^h 12^m 39^s$ = sidereal hour angle.

- 42 = reduction to mean time hour angle.

$4^h 11^m 57^s$ = mean time hour angle.

2nd Star: No. 13/20, β Geminorum (Pollux); $\delta = +28^\circ 09' 42''$; meri-

dian passage = $3^h 06.1^m$ p.m., l.m.t., May 31, 1945, for time and azimuth.

Tel.	Watch time p.m.	Hor. Ang.	Observed Vert. Ang.
Dir.	$7^h 19^m 59^s$	$84^\circ 06' 00''$	$37^\circ 22' 00''$
"	7 20 53	83 57 00	37 12 00
Rev.	7 23 39	83 31 00	36 40 30
"	7 24 53	83 19 00	36 28 00
Mean	$7^h 22^m 21^s$	$83^\circ 43' 15''$	

Refraction, $r = 36^\circ 55' 37''$
 = - 1 17

$h = 36^\circ 54' 20''$

$N. 83^\circ 41' 57'' W.$ = Reduced azimuth of star.

$N. 00^\circ 01' 18'' E.$ = Indicated bearing of reference mark.

$3^h 06^m 06^s$ = Mer. pass. of star, p.m., l.m.t.

$4 16 43$ = Reduced mean time hour angle.

$7^h 22^m 49^s$ $7^h 22^m 49^s$ = Local mean time of observation.

$0^m 28^s$ = Watch slow of l.m.t.

Star's transit, May 16, meridian of Greenwich = $4^h 05.9^m$ p.m.

Reduction to " 31 = - 59.0
 " long. $73^\circ 35' 15''$ = - 0.8

Meridian passage of star, l.m.t. = $3^h 06.1^m$ p.m.

The first part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \frac{1}{x} \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function. The second part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \frac{1}{x} \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function. The third part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \frac{1}{x} \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function. The fourth part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \frac{1}{x} \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function. The fifth part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \frac{1}{x} \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function. The sixth part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \frac{1}{x} \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function. The seventh part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \frac{1}{x} \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function. The eighth part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \frac{1}{x} \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function. The ninth part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \frac{1}{x} \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function. The tenth part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \frac{1}{x} \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function.

2nd Star: No. 13/20:

$\phi = 42^{\circ}44'03''$

$\delta = +28^{\circ}09'42''$

$h = 36^{\circ}54'20''$

$$\cos t = \frac{\sin h}{\cos \phi \cos \delta} - \tan \phi \tan \delta$$

$$\cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h$$

log	<u>cos</u>	<u>sin</u>	<u>tan</u>
-----	------------	------------	------------

<u>cos</u>	<u>sin</u>	<u>tan</u>
------------	------------	------------

$h = 9.778511$

9.902887

9.875624

$\phi = 9.865998$

9.865998

9.965615

$\delta = 9.945281$

9.965615

9.965615

9.728625

9.673906

9.811279

9.811279

9.768885

9.841239

9.694240

9.768885

9.967232

9.905021

nat

$.92733$

$.49458$

$.80356$

$.69381$

$.49458$

$.69381$

$\cos t = .43275 (+)$

$\cos A = .10975 (+)$

$t = 64^{\circ}21'28''$

$A = 83^{\circ}41'57''W.$

$4^h 17^m 26''$

= sidereal hour angle.

$- 43$

= reduction to mean time hour angle.

$4^h 16^m 43''$

= mean time hour angle.

3rd Star: No. 4/6; α Urs. Min. (Polaris); $\delta = +89^{\circ}00'00''$; meridianpassage at upper culmination = $9^h 10^m 00^s$ a.m., l.m.t., May 31, 1945; sun-

set observation for azimuth and latitude.

Tel.	Watch time p.m.	Hor. Ang. Repeated	Observed Vert. Ang.
Dir.	$7^h 28^m 03^s$	$0^{\circ}34'30''$	$41^{\circ}50'30''$
"	$7 30 07$		$41 49 00$
"	$7 32 35$	$1^{\circ}41'30''$	$41 49 00$
Mean	$7^h 30^m 15^s$	$0^{\circ}33'50''$ (1/5)	$41^{\circ}49'30''$
Rev.	$7^h 35^m 01^s$	$0^{\circ}33'00''$	$41^{\circ}50'00''$
"	$7 36 33$		$41 50 00$
"	$7 38 07$	$1^{\circ}38'00''$	$41 50 00$
Mean	$7^h 36^m 34^s$	$0^{\circ}32'40''$ (1/3)	$41^{\circ}50'00''$
	$7^h 33^m 24^s$	$0^{\circ}33'15''$ Mean of all.	$\gamma = 41^{\circ}49'45''$
	$0 27$	Watch slow of l.m.t.	Refraction, $r = -1.04$
	$7^h 33^m 51^s$	p.m., l.m.t. of observation.	$h = 41^{\circ}48'41''$
	12		
U.C.	$9^h 10^m 00^s$	a.m.	
	$10^h 23^m 51^s$	= Hour angle of Polaris, west of meridian.	

3rd Star: Polaris:

Vertical angle, corrected for refraction: $h = 41^{\circ}48'41''$ Vertical angle correction to elevation of pole for hour angle $10^h 23.85^m$, additive: $= + 0^{\circ}55'03''$ Latitude: $= 42^{\circ}43'44''$ Observed horizontal angle: $= 0^{\circ}33'15''$ Azimuth of Polaris for hour angle $10^h 23.85^m$ west of the meridian: $A = N.0^{\circ}32'18''W.$ Indicated bearing of reference mark: $N.0^{\circ}00'57''E.$ Same, 1st equatorial star, SE.: $N.0^{\circ}00'16''E.$
" 2nd " " , NW.: $N.0^{\circ}01'18''E.$ Mean of the equatorial stars: $N.0^{\circ}00'47''E. \quad N.0^{\circ}00'47''E.$ Determined true bearing of reference mark: $N.0^{\circ}00'52''E.$ Upper culmination, May 31, meridian of Greenwich: $9^h10.8^m$ a.m.
Reduction to long. $73^{\circ}35'15''$ $= - 0.8$ $9^h10.0^m$ a.m.

Interpolation from tables in the Ephemeris:

For azimuth.				For latitude.		
Hour Angle.	Latitude.			Declination.		
	<u>$42^{\circ}00'$</u>	<u>$42^{\circ}44'$</u>	<u>$44^{\circ}00'$</u>	<u>$88^{\circ}59'50''$</u>	<u>$89^{\circ}00'00''$</u>	<u>$89^{\circ}00'10''$</u>
$10^h 18.3^m$	33.5		34.5			
22.3						
23.85	31.7	32.1	32.7	$0^{\circ}55'03''$	$0^{\circ}54'54''$	$0^{\circ}54'45''$
26.3					0 55 03	
34.3	30.3		31.3	<u>0 56 14</u>	<u>0 56 05</u>	<u>0 55 56</u>

For $\delta = 89^{\circ}00'00'' + 0.2$

32.3

Primary adjustment to elevation of pole, additive; no supplemental correction:

 $A = N.0^{\circ}32'18''W.$ $0^{\circ}55'03''$

4th Star: No. 17/33; α Virginis (Spica); $\delta = -10^{\circ}52'36''$; meridian passage = $8^h 45.6^m$ p.m., l.m.t., May 31, 1945; for time and latitude.

Star's transit, May 16, meridian of Greenwich = $9^h 45.4^m$ p.m.
 Reduction to " 31 = - 59.0
 " " long. $73^{\circ}35'15''$ = - 0.8

Meridian passage of star, l.m.t. = $8^h 45.6^m$ p.m.
 = $8^h 45.6^m$ p.m.

	Observed time	Watch time	
Tel.	Vert. Ang.	p.m.	
Dir.	$36^{\circ}24'00''$	$8^h 45^m 06^s$	Watch time = $8 45 06$
Rev.	$36 24 30$		
		Watch slow of l.m.t.	= $0^m 30^s$
Mean	$36^{\circ}24'15''$	Same, 1st star	= $0 23$
	- 1 18 = refraction.	" 2nd "	= $0 28$
	$36^{\circ}22'57''$ = h	Mean	= $0^m 27^s$
	$\delta = 10 52 36$ S.		
	$47^{\circ}15'33''$		
$\varphi = 42 44 27$	= Latitude of station		= $42^{\circ}44'27''$
<u>$90^{\circ}00'00''$</u>	Same, by Polaris observation		= $42 43 44$
		Mean	<u>$42^{\circ}44'05''$</u>

Stellar Hour Angle Observation for Azimuth and Time.

Observer: Geo. F. Rigby

Recorder: Norman D. Price

Date: October 26, 1944. Instrument: W. & L. E. Gurley No. 2350

October 26, 1944, in the SW $\frac{1}{4}$ of sec. 25, T. 1 N., R. 1 E., Willamette Meridian, Oregon, latitude $45^{\circ} 32' 30''$ N., and longitude $122^{\circ} 39' 00''$ W., at 4^h 00^m p. m., app. t., or 4^h 54.6^m p. m., by my watch which reads correct Pacific War Time, I set off $45^{\circ} 32' 30''$ N., on the lat. arc; $12^{\circ} 36' 15''$ S., on the decl. arc; and determine a meridian with the solar, setting a nail on the meridian thus determined in a hub 10 chs. N. of my station. After dark, to test this indication of the solar and the reading of my watch, I make a series of six altitude observations of the star alpha Ophiuchi for azimuth and time, three each with the telescope in direct and reversed positions, reading the horizontal deflection angles from hub to star.

Star: 22/44 2.1

Alpha Ophiuchi

 $\uparrow 12^{\circ} 36.4'$

Obs'n.	Telescope	Watch Time	Vertical Angle	Horizontal Angle from hub to star
1	Direct	6 ^h 50 ^m 05 ^s	44° 33' 30" r -0 59 44° 32' 31"	55° 32' 00" SW.
2	Direct	6 ^h 51 ^m 16 ^s	44° 24' 00" r -0 59 44° 23' 01"	55° 50' 30" SW.
3	Direct	6 ^h 52 ^m 21 ^s	44° 13' 00" r -1 00 44° 12' 00"	56° 11' 00" SW.
4	Reversed	6 ^h 54 ^m 59 ^s	43° 52' 00" r -1 00 43° 51' 00"	56° 50' 00" SW.
5	Reversed	6 ^h 58 ^m 55 ^s	43° 17' 30" r -1 01 43° 16' 29"	57° 53' 30" SW.
6	Reversed	7 ^h 00 ^m 13 ^s	43° 05' 30" r -1 02 43° 04' 28"	58° 14' 30" SW.

r = refraction in zenith distance.

The following table shows the results of the tests conducted on the various samples of the material under consideration. The results are given in terms of the percentage of the material which is found to be of the various types. The results are given in the following table:

Sample	Percentage of Material of Various Types
1	100%
2	100%
3	100%
4	100%
5	100%
6	100%
7	100%
8	100%
9	100%
10	100%
11	100%
12	100%
13	100%
14	100%
15	100%
16	100%
17	100%
18	100%
19	100%
20	100%
21	100%
22	100%
23	100%
24	100%
25	100%
26	100%
27	100%
28	100%
29	100%
30	100%
31	100%
32	100%
33	100%
34	100%
35	100%
36	100%
37	100%
38	100%
39	100%
40	100%
41	100%
42	100%
43	100%
44	100%
45	100%
46	100%
47	100%
48	100%
49	100%
50	100%
51	100%
52	100%
53	100%
54	100%
55	100%
56	100%
57	100%
58	100%
59	100%
60	100%
61	100%
62	100%
63	100%
64	100%
65	100%
66	100%
67	100%
68	100%
69	100%
70	100%
71	100%
72	100%
73	100%
74	100%
75	100%
76	100%
77	100%
78	100%
79	100%
80	100%
81	100%
82	100%
83	100%
84	100%
85	100%
86	100%
87	100%
88	100%
89	100%
90	100%
91	100%
92	100%
93	100%
94	100%
95	100%
96	100%
97	100%
98	100%
99	100%
100	100%

Stellar Hour Angle Observation for Azimuth and Time.

Azimuth

$$\cos A = \frac{\sin d}{\cos \phi \cos h} - \tan \phi \tan h$$

A = Star's azimuth
 d = Declination
 h = Altitude corrected for ref.
 ϕ = Latitude

log sin d	| 9.338855 |								
log cos ϕ	| 9.845341 |								
diff.	| 9.493514 |	| 9.493514 |	| 9.493514 |	| 9.493514 |	| 9.493514 |	| 9.493514 |	| 9.493514 |	| 9.493514 |	
log cos h	| 9.852930 |	| 9.854107 |	| 9.855465 |	| 9.858029 |	| 9.862177 |	| 9.863601 |			
diff.	| 9.640584 |	| 9.639407 |	| 9.638049 |	| 9.635485 |	| 9.631337 |	| 9.629913 |			
1st term	| .43710 |	| .43592 |	| .43456 |	| .43200 |	| .42790 |	| .42649 |			
log tan ϕ	| .008212 |	| .008212 |	| .008212 |	| .008212 |	| .008212 |	| .008212 |			
log tan h	| 9.993056 |	| 9.990655 |	| 9.987871 |	| 9.982562 |	| 9.973829 |	| 9.970787 |			
sum	| .001268 |	| .998867 |	| 9.996083 |	| 9.990774 |	| 9.982041 |	| 9.978999 |			
2nd term	| 1.00292 |	| .99740 |	| .99102 |	| .97898 |	| .95949 |	| .95279 |			
nat. cos A	| .56582 |	| .56148 |	| .55646 |	| .54698 |	| .53159 |	| .52630 |			
angle A	| 55 32 28 |	| 55 50 30 |	| 56 11 20 |	| 56 50 24 |	| 57 53 12 |	| 58 14 38 |			
hor. angle	| 55 32 00 |	| 55 50 30 |	| 56 11 00 |	| 56 50 00 |	| 57 53 30 |	| 58 14 30 |			
azimuth	| S. 0° 00' 28" W. |								
"	| South |								
"	| S. 0° 00' 20" W. |								
"	| S. 0° 00' 24" W. |								
"	| S. 0° 00' 18" E. |								
"	| S. 0° 00' 08" W. |								
Mean azimuth S. 0° 00' 10" W.									

Time.

$$\cos t = \frac{\sin h}{\cos \phi \cos d} - \tan \phi \tan d$$

t = Star's hour angle
 d = Declination
 h = Altitude corrected for ref.
 ϕ = Latitude

log sin h	| 9.845985 |	| 9.844762 |	| 9.843336 |	| 9.840591 |	| 9.836006 |	| 9.834388 |			
log sin ϕ	| 9.845341 |	| 9.845341 |	| 9.845341 |	| 9.845341 |	| 9.845341 |	| 9.845341 |			
diff.	| .000644 |	| 9.999421 |	| 9.997995 |	| 9.995250 |	| 9.990665 |	| 9.989047 |			
log cos d	| 9.989407 |	| 9.989407 |	| 9.989407 |	| 9.989407 |	| 9.989407 |	| 9.989407 |			
diff.	| .011237 |	| .010014 |	| .008588 |	| .005843 |	| .001258 |	| 9.999640 |			
1st term	| 1.02621 |	| 1.02330 |	| 1.01997 |	| 1.01355 |	| 1.00290 |	| .99917 |			
log tan ϕ	| .008212 |								
log tan d	| 9.349448 |								
sum	| 9.357660 |								
2nd term	| .22786 |	| .22786 |	| .22786 |	| .22786 |	| .22786 |	| .22786 |			
nat. cos t	| .79835 |	| .79544 |	| .79211 |	| .78569 |	| .77504 |	| .77131 |			
t	| 37 01 39 |	| 37 18 11 |	| 37 37 00 |	| 38 12 57 |	| 39 11 28 |	| 39 31 41 |			
h m s	| h m s |	| h m s |	| h m s |	| h m s |	| h m s |	| h m s |			
red. to time	| 2 28.07 |	| 2 29 13 |	| 2 30 28 |	| 2 32 52 |	| 2 36 46 |	| 2 38 07 |			
red. to m.t.	| -25 |	| -25 |	| -25 |	| -25 |	| -26 |	| -26 |			
l. m. t.	| 2 27 42 |	| 2 28 48 |	| 2 30 03 |	| 2 32 27 |	| 2 36 20 |	| 2 37 41 |			
transit t.	| 3 11 34 |	| 3 11 34 |	| 3 11 34 |	| 3 11 34 |	| 3 11 34 |	| 3 11 34 |			
l.m.t. obsn	| 5 39 16 |	| 5 40 22 |	| 5 41 37 |	| 5 44 01 |	| 5 47 54 |	| 5 49 15 |			
red. P.W.T.	| 1 10 36 |	| 1 10 36 |	| 1 10 36 |	| 1 10 36 |	| 1 10 36 |	| 1 10 36 |			
P.W.T. obsn	| 6 49 52 |	| 6 50 58 |	| 6 52 13 |	| 6 54 37 |	| 6 58 30 |	| 6 59 51 |			
watch time	| 6 50 05 |	| 6 51 16 |	| 6 52 21 |	| 6 54 59 |	| 6 58 55 |	| 7 00 13 |			
watch fast	| 0 00 13 |	| 0 00 18 |	| 0 00 08 |	| 0 00 22 |	| 0 00 25 |	| 0 00 22 |			
Mean: watch 18 seconds fast of Pacific War Time									

DIRECT ALTITUDE OBSERVATION UPON THE SUN FOR AZIMUTH, IN ALASKA

Data : September 9, 1945. Observer: B.J. Kineasy. Instrument: Buff No. 18,000.

At my station 10 chs. east of the 2 sec. cor. of secs. 13 and 18, T.3 N., R.11 W., Seward Base and Meridian, Alaska, in latitude 60°21'N. and longitude 151°20'W., I make a series of four observations upon the sun for azimuth, each with the telescope in direct and reversed positions, observing opposite limbs of the sun, and reading the deflection angle from a flag-pole about 10 chs. to the S., SW to the sun!

Observation	Telescope	Sun	Watch time Std. War	Vertical angle	Horizontal angle	flag to sun
1st. set	Direct	☉	5h09m	18°46'	65°32'	to SW.
" "	Reversed	☉	5h11m	19°09'	66°21'	" "
" "	Mean		5h10m	18°57'30"	65°56'30"	" "
2nd. "	Direct	☉	5h13m	18°31'	66°35'	" "
" "	Reversed	☉	5h15m	18°56'	66°15'	" "
" "	Mean		5h14m	18°43'30"	66°25'	" "
3rd. "	Direct	☉	5h16m	18°16'	66°32'	" "
" "	Reversed	☉	5h18m	18°41'	67°20'	" "
" "	Mean		5h17m	18°28'30"	66°56'	" "
4th. "	Direct	☉	5h20m	18°01'	67°36'	" "
" "	Reversed	☉	5h21m	18°28'	67°14'	" "
" "	Mean		5h20m30s	18°14'30"	67°25'	" "

The declination of the sun for the mean period of the four observations = 5°08' N.

The following reductions are accomplished to obtain the true vertical angles of the above observations:

	1st. obsn.	2nd. obsn.	3rd. obsn.	4th. obsn.
Refraction	- 18°57'30"	- 18°43'30"	- 18°28'30"	- 18°14'30"
Parallax	+ 2'46"	+ 2'48"	+ 2'51"	+ 2'54"
	8"	8"	8"	8"
h	18°54'52"	18°40'50"	18°25'47"	18°11'44"

The reduction of the above series is accomplished by the equation:

$$\cos A = \frac{\cos L \sin D}{\sin H} - \tan L \tan H$$

1st. set	Log Sin D = 8.9516957	Log Tan L = 0.2447092
"	" Cos L = 9.6947423	" " H = 9.5342611
"	" " H = 9.2577534	"2nd. term = 9.7795703
"	" " H = 9.9758929	
"1st. term	= 9.2814605	.60196 " "
"	" " = .19119	
"	" " = .41077	
Nat. Cos A		
Angle A	= 65°45'	
2nd. set	Log Sin D = 8.9516957	Log Tan L = 0.2447092
"	" Cos L = 9.6947423	" " H = 9.5290145
"	" " H = 9.2577534	"2nd. term = 9.7737237
"	" " H = 9.9764964	
"1st. term	= 9.2808571	.59396 " "
"	" " = .19088	
"	" " = .40304	
Nat. Cos A		
Angle A	= 66°14'	
3rd. Set	Log Sin D = 8.9516957	Log Tan L = 0.2447092
"	" Cos L = 9.6947423	" " H = 9.5227456
"	" " H = 9.2577534	"2nd. term = 9.7674558
"	" " H = 9.9771345	
"1st. term	= 9.2802189	.58540 " "
"	" " = .19065	
"	" " = .39475	
Nat. Cos A		
Angle A	= 66°45'	
4th. set	Log Sin D = 8.9516957	Log Tan L = 0.2447092
"	" Cos L = 9.6947423	" " H = 9.5167964
"	" " H = 9.2577534	"2nd. term = 9.7615054
"	" " H = 9.9777219	
"1st. term	= 9.2796315	.57743 " "
"	" " = .19038	
"	" " = .39705	
Nat Cos A		
Angle A	= 67°14'	

Bearing of flagpole:

1st. obsn.	: S. 0°11'30" E.
2nd. "	: S. 0°11'00" E.
3rd. "	: S. 0°11'00" E.
4th. "	: S. 0°11'00" E.
Mean	: S. 0°11'07" E.

STELLAR OBSERVATION FOR MERIDIAN IN ALASKA

Date: September 9, 1945. Observer: B.J. Kinsey Instrument: Buff 18,000.

Star: 19/35 0.2 S = 19° 28.1' N.
Bootis (Aroturus)Gr.m.t. stars transit, September 1 : 3h31m p.m.
Red. to " 9 : - 31.5m
" " long. 151°20'W. " " : - 1.5m
Stars transit l.m.t. " " : 2h57.9m
Watch test of l.m.t. " : 0h59m13s

At my station 10 chs. east of the $\frac{1}{2}$ sec. cor. of secs. 13 and 18, T.3 N., R.11 W., Seward Base and Meridian, Alaska, in latitude 60°21'N. and longitude 151°20'W., I make four altitude observations upon the star Aroturus for azimuth, two each with the telescope in direct and reversed positions and reading the horizontal deflection from a flagpole set about 10 chs. S.0°11'E., as determined by previous altitude observations upon the sun for azimuth.

Position of Telescope		Time: Std. watch	Horizontal angle	Vertical angle
1st. set	Direct :	7h14m p.m.	93°50'00"	20°30'00"
" "	Reversed :	7h15m "	94°12'00"	20°18'00"
	Mean :	7h14m30s p.m.	94°01'00"	20°24'00"
			Refraction :	2'12"
			True vertical angle :	20°21'28"
2nd. set	Direct :	7h16m p.m.	94°29'00"	20°06'00"
" "	Reversed :	7h17m "	94°45'00"	20°00'00"
	Mean :	7h16m30s p.m.	94°37'00"	20°03'00"
			Refraction :	2'37"
			True vertical angle :	20°00'23"

The reduction of the above series is accomplished by the equation:

$$\cos A = \frac{\sin D}{\cos L \cos H} - \tan L \tan H$$

1st. set

$$\begin{array}{ll} \log \sin D = 9.5227811 & \log \tan L = 0.2447092 \\ \text{" } \cos L = 9.6943423 & \text{" } H = 9.5624289 \\ \text{" } H = 9.8284388 & \text{2nd. term} = 9.8141381 \\ \text{" 1st. term} = 9.9719907 & \\ \text{" " " " } = 9.8564481 & \\ & .71853 \\ & .65184 \\ \text{Nat. } \cos A = .06669 \text{ NW.} & \\ \text{Angle } A = 86^{\circ}10'30'' \text{ (star to NW).} & \\ \text{Bearing of reference point by this observation : S.0°11'30"E.} & \end{array}$$

2nd. set

$$\begin{array}{ll} \log \sin D = 9.5227811 & \log \tan L = 0.2447092 \\ \text{" } \cos L = 9.6943423 & \text{" } H = 9.5624289 \\ \text{" } H = 9.8284388 & \text{2nd. term} = 9.8099297 \\ \text{" 1st. term} = 9.9722682 & \\ \text{" " " " } = 9.8554706 & \\ & .71692 \\ & .63962 \\ \text{Nat } \cos A = .07730 \text{ NW.} & \\ \text{Angle } A = 85^{\circ}34' \text{ (star to NW).} & \\ \text{Bearing of reference point by this observation : S.0°11'E.} & \end{array}$$

Memo:

Azimuth by obsn. on Aroturus (westerly), mean = S. 0° 11' 15" E.
 " " " " Sun (southwest), mean = S. 0 11 07 E.
 " " " " Polaris (north) Mean = S. 0° 11' 11" E.
 = S. 0 11 00 E.
 Balanced azimuth = S. 0° 11' 05" E.

...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

OBSERVATION UPON POLARIS AT ELONGATION
(ALASKA)

Date: September 9, 1945. Observer: B.J. Kinsey. Instrument: Buff 18,000.

September 9, 1945, Gr. E.E. of Polaris, Lat, 60°21' N.: 8h 36.0m, p.m.
 Red. to long. 151°20'W. : 1.6m
 " " lat. 60°21'N. : 3.7m
 L.M.T. of E.E. of Polaris : 8h 38.1m p.m.

Sept. 9, 1945:

At my station 10 chs. east of the $\frac{1}{2}$ sec. cor. of secs. 13 and 18, T.3 N., R.11 W., Seward Pass and Meridian, Alaska, in latitude 60°21'N. and longitude 151°20'W., at 8h36m., p.m. l.m.t. I observe Polaris at eastern elongation, making two observations, one each with telescope in direct and reversed positions, deflecting angles from a reference point established previously by direct observation upon the sun for azimuth, the solar bearing of which is S.0°10'31"E.

Telescope	Time	Horizontal angle	Vertical
	Watch: Std. War.	reference pt. to star.	angle.
Direct : 1	9h 37m., p.m.	N. 2° 12' E.	60° 20' 30"
Reversed : 1	9h 37m., "	N. 2° 11' E.	60° 21' 30"
Mean : 1	9h 36m "	N. 2° 11' 30" E.	60° 21' 00"

Azimuth of Polaris at E.E. : 2° 00' 59".

Declination of Polaris : 89° 00' 08".

Watch fast of l.m.t. : 0h 59m 13s

The bearing of the reference point by Polaris obsn. is therefore S.0°10'31"E.

OBSERVATION UPON THE SUN FOR TIME AND LATITUDE
(ALASKA)

Date: September 10, 1945.

At same station as described above, I make a meridian obsn. of the sun for time and latitude, observing simultaneously the altitude of the suns lower limb and the transit of the suns west limb, reversing the telescope and observing simultaneously the altitude of the suns upper limb and the transit of the suns east limb:

Telescope	Sun	Time: Std. War.	Altitude
Direct : 1	☉	12h 55m 10s p.m.	34° 14'
Reversed : 1	☉	12h 57m 20s "	34° 45'
Mean : 1		12h 56m 15s "	34° 29' 30"
		Refraction: -	1' 22"
			34° 28' 08"
		Parallax : +	07"
		True altitude:	34° 28' 15"
Watch time of apparent noon =		12h 56m 15s	
Apparent noon =		12h 00m 00s	
Erection of time =		2m 53s	
L.m.t. of apparent noon =		11h 57m 02s	
Watch fast of l.m.t. =		59m 13s	
Suns declination, Gr. noon =			4° 53' 43" N.
Red. to long. 151°20'W. =		or 10h 5m	
" " time of obsn. =		56.86s x 10 hrs. x 56.86(568") =	0° 29"
Declination of the sun at apparent noon:			4° 49' 14"
			+90° 00' 00"
			94° 49' 14"
			- 34° 28' 08"
			60° 21' 06"
Latitude of station =			

1. The first part of the report deals with the general situation of the country and the results of the survey. It is divided into two main sections: the first section deals with the general situation of the country and the results of the survey, and the second section deals with the specific results of the survey.

2. The second part of the report deals with the specific results of the survey. It is divided into three main sections: the first section deals with the results of the survey in the field of agriculture, the second section deals with the results of the survey in the field of industry, and the third section deals with the results of the survey in the field of commerce.

3. The third part of the report deals with the conclusions of the survey. It is divided into two main sections: the first section deals with the conclusions of the survey in the field of agriculture, and the second section deals with the conclusions of the survey in the field of industry and commerce.

4. The fourth part of the report deals with the recommendations of the survey. It is divided into two main sections: the first section deals with the recommendations of the survey in the field of agriculture, and the second section deals with the recommendations of the survey in the field of industry and commerce.

5. The fifth part of the report deals with the appendix. It is divided into two main sections: the first section deals with the appendix in the field of agriculture, and the second section deals with the appendix in the field of industry and commerce.

6. The sixth part of the report deals with the bibliography. It is divided into two main sections: the first section deals with the bibliography in the field of agriculture, and the second section deals with the bibliography in the field of industry and commerce.

7. The seventh part of the report deals with the index. It is divided into two main sections: the first section deals with the index in the field of agriculture, and the second section deals with the index in the field of industry and commerce.

8. The eighth part of the report deals with the conclusion. It is divided into two main sections: the first section deals with the conclusion in the field of agriculture, and the second section deals with the conclusion in the field of industry and commerce.

9. The ninth part of the report deals with the summary. It is divided into two main sections: the first section deals with the summary in the field of agriculture, and the second section deals with the summary in the field of industry and commerce.

10. The tenth part of the report deals with the final remarks. It is divided into two main sections: the first section deals with the final remarks in the field of agriculture, and the second section deals with the final remarks in the field of industry and commerce.

O - 2

Polaris at sunrise and sunset; the sun at meridian passage; time, latitude, and azimuth.

Camp Case, Mohican Forest Park, Latitude: $40^{\circ}36'22''N$. Longitude: $82^{\circ}18'33''W$. Loudonville, Ohio.

July 31, 1940. Arthur D. Kidder, observing; Buff No. 10898
watch reading approximate General Land Office
local mean time. solar transit.

Horizontal angles at my station at the camp, reading to a flag pole on a building which by observation I find to bear $N.25^{\circ}13'16''E$, $1\frac{1}{2}$ Mi. dist.

Tel.	Watch Time	Hor. Ang.	U.C., Gr., July 31:	$5^h 09.0^m$ a.m.	Observed
	a.m.	NE-W	Red. for long.	$- 0.2$	Vert. Ang.
Rev.	$4^h 36^m 30^s$	$25^{\circ}02'00''$	U.C., l.m.t.:	$5^h 08.1^m$ a.m.	$41^{\circ}39'00''$
Dir.	$4^h 46^m 30^s$	$25^{\circ}06'00''$			$41^{\circ}38'30''$
Mean	$4^h 41^m 30^s$	$25^{\circ}04'00''$	Decl. =	$88^{\circ}58'33''N$.	$v = 41^{\circ}38'45''$
Watch					$r = - 1.05$
slow of					
l.m.t.	$1^m 00^s$				$h = 41^{\circ}37'40''$

L.M.T.	$4^h 46^m 30^s$		Subtract to elevation of pole	$= 1.105$
U.C.	$5^h 08^m 06^s$	$0^{\circ}09'12'' =$ Azimuth	Latitude	$= 40^{\circ}36'37''$
Hour Ang.	$0^h 25^m 36^s$	$N.25^{\circ}13'12''E$.	$=$ Indicated bearing to flag pole.	

Dir.	$7^h 15^m 35^s$	$24^{\circ}30'30''$	U.C., Gr., Aug. 1:	$5^h 05.1^m$ a.m.	
Rev.	$7^h 18^m 00^s$	$24^{\circ}29'00''$	Red. for long.	$- 0.2$	
Mean	$7^h 16^m 48^s$	$24^{\circ}29'45''$	U.C., l.m.t.:	$5^h 04.2^m$ a.m.	$39^{\circ}46'00''$
Watch					$39^{\circ}47'00''$
slow of					
l.m.t.	$1^m 00^s$				$v = 39^{\circ}46'30''$
					$r = - 1.10$

L.M.T.	$7^h 17^m 48^s$		Add to elevation of pole	$= 0.5144$
U.C.	12^h	$0^{\circ}43'36'' =$ Azimuth	Latitude	$= 40^{\circ}37'04''$
Aug. 1	$5^h 04^m 12^s$	$N.25^{\circ}13'21''E$.	$=$ Flag pole.	
Hour Ang.	$9^h 46^m 24^s$	$N.25^{\circ}13'16''E$.	Mean latitude	$= 40^{\circ}36'50''$
east		$=$ Mean indicated bearing to flag pole.		

Tel.	Sun	Watch Time	Apparent noon	$12^h 00^m 00^s$	Observed
			Equation of time	$+ 6^m 14^s$	Vert. Ang.
Rev.	$\frac{d}{f}$	$12^h 04^m 08^s$	App. noon, l.m.t.	$12^h 06^m 14^s$	$67^{\circ}20'30''$
		$+ 1^m 06^s$	Add to time for sun's center.		
Dir.	$\frac{+}{0}$	$12^h 05^m 14^s$			$67^{\circ}51'30''$
L.M.T.		$12^h 06^m 14^s$	Decl. =	$18^{\circ}11'15''N$.	$v = 67^{\circ}36'00''$
U.C.				$90^{\circ}00'00''$	$r = - 24$
Watch slow		$1^m 00^s$			$p = + 04$
				$108^{\circ}11'15''$	$h = 67^{\circ}35'40''$
				$67^{\circ}35'40''$	

Mean of two observations on Polaris = $40^{\circ}35'35'' =$ Latitude
= $40^{\circ}36'50''$

Balanced mean latitude = $40^{\circ}36'12''$
Topographic map U.S.G.S. = $40^{\circ}36'22''$

For demonstration of the General Land Office solar transit, meeting of The Society for the Promotion of Engineering Education, Civil Engineering Division, Surveying and Geodesy.

1. The first part of the report is a general statement of the purpose and scope of the investigation.

2. The second part is a description of the methods used in the investigation.

3. The third part is a description of the results of the investigation.

4. The fourth part is a discussion of the results of the investigation.

5. The fifth part is a conclusion of the investigation.

6. The sixth part is a list of references.

7. The seventh part is a list of tables.

8. The eighth part is a list of figures.

9. The ninth part is a list of appendices.

10. The tenth part is a list of errata.

11. The eleventh part is a list of acknowledgments.

12. The twelfth part is a list of footnotes.

13. The thirteenth part is a list of references.

14. The fourteenth part is a list of tables.

15. The fifteenth part is a list of figures.

16. The sixteenth part is a list of appendices.

17. The seventeenth part is a list of errata.

18. The eighteenth part is a list of acknowledgments.

19. The nineteenth part is a list of footnotes.

20. The twentieth part is a list of references.

21. The twenty-first part is a list of tables.

22. The twenty-second part is a list of figures.

23. The twenty-third part is a list of appendices.

24. The twenty-fourth part is a list of errata.

25. The twenty-fifth part is a list of acknowledgments.

26. The twenty-sixth part is a list of footnotes.

27. The twenty-seventh part is a list of references.

28. The twenty-eighth part is a list of tables.

29. The twenty-ninth part is a list of figures.

30. The thirtieth part is a list of appendices.

EQUAL ALTITUDE OBSERVATION OF THE SUN

Observer: John S. Knowles
 Instrument: Buff solar transit No. 23819
 Watch: Illinois- Dunn Special

September 2, 1944, near the corner of secs. 5, 6, 31, and 36, on the south boundary of T. 13 S., R. 90 W., New-Mexico Principal Meridian, Colorado, in latitude $38^{\circ} 52'.4$ N. and longitude $107^{\circ} 29'$ W., at 8h 34m a.m. and 3h 30m p.m. app. t., I make a series of three altitude observations upon the sun for azimuth, reading the horizontal deflection angle from a nail driven firmly in a post about 6 cms. N.E., clockwise in the a.m. to the sun's right limb, and counter-clockwise in the p.m. to the sun's left limb; equal vertical angles being taken to the sun's lower limb.

Observation Sun Watch time Vertical Angle Horizontal angle from reference point to sun

1st a. m.	\odot	9h 44m 12s	$34^{\circ} 15' 00''$	$104^{\circ} 8' 30''$ to E.
3rd p. m.	\odot	4 35 28		$116^{\circ} 37' 30''$ to W.
				$12^{\circ} 29' 00''$ Diff.
2nd a.m.	\odot	9h 46m 28s	$34^{\circ} 40' 00''$	$104^{\circ} 36' 30''$ to E.
2nd p.m.	\odot	4 33 10		$117^{\circ} 5' 30''$ to W.
		6 46 42		$12^{\circ} 29' 00''$ Diff.
3rd a.m.	\odot	9h 49m 7s	$35^{\circ} 08' 00''$	$105^{\circ} 10' 00''$ to E.
1st p.m.	\odot	4 40 36		$117^{\circ} 38' 30''$ to W.
				$12^{\circ} 28' 30''$ Diff.

One-half differences, or bearing angles from uncorrected north point to reference point:

By 1st obsn. N. $6^{\circ} 14' 30''$ E.
 By 2nd obsn. N. $6^{\circ} 14' 30''$ E.
 By 3rd obsn. N. $6^{\circ} 14' 15''$ E.

Mean N. $6^{\circ} 14' 25''$ E.
 Differential azimuth correction - $5' 08''$

Mean true bearing of ref. pt. N. $6^{\circ} 9' 17''$ E.

$\frac{1}{2} \Delta d :: \frac{1}{2} \times 6.78 \times 54.76 :: 186''$ $\log \frac{1}{2} \Delta d :: 2.269513$
 $\phi 38^{\circ} 52'.4$ N.: $\log \cos \phi$ 9.891278
 $\frac{1}{2}(t_1 + t_2)$ 3h 23m 21s
 $\frac{50^{\circ} 40' 15''}{2} (50^{\circ} 50' 15'')$
 $\log \sin \frac{1}{2}(t_1 + t_2)$ 9.883400
 9.780678
 $\log d \Delta d$ 2.488335

Differential azimuth correction 308"

5' 8"

PUBLISHED WEEKLY
535 N. Dearborn Ave., Chicago 10, Ill.
Subscription price, \$5.00 per annum in advance

CONTENTS
ORIGINAL ARTICLES
The Role of the General Practitioner in the Management of the Patient with a Heart Problem
The Role of the General Practitioner in the Management of the Patient with a Lung Problem
The Role of the General Practitioner in the Management of the Patient with a Kidney Problem

DEPARTMENTS
Book Reviews
Editorial Comments

Page	Page	Page	Page
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
58	58	58	58
59	59	59	59
60	60	60	60
61	61	61	61
62	62	62	62
63	63	63	63
64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
68	68	68	68
69	69	69	69
70	70	70	70
71	71	71	71
72	72	72	72
73	73	73	73
74	74	74	74
75	75	75	75
76	76	76	76
77	77	77	77
78	78	78	78
79	79	79	79
80	80	80	80
81	81	81	81
82	82	82	82
83	83	83	83
84	84	84	84
85	85	85	85
86	86	86	86
87	87	87	87
88	88	88	88
89	89	89	89
90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100

Published by the American Medical Association, 535 N. Dearborn Ave., Chicago 10, Ill.
Copyright, 1954, by American Medical Association

ALL RIGHTS RESERVED
No part of this publication may be reproduced without permission in writing from the American Medical Association

Printed at the American Medical Association Press, Chicago, Ill.

Second-class postage paid at Chicago, Ill., and at additional mailing offices

POSTMASTER: Send address changes in U.S.A. to JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, 535 N. Dearborn Ave., Chicago 10, Ill.

Subscription price, \$5.00 per annum in advance
Single copies, 15¢
Entered as Second-Class Matter, May 2, 1917
Postage paid at Chicago, Ill., and at additional mailing offices
Postmaster: Send address changes in U.S.A. to JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, 535 N. Dearborn Ave., Chicago 10, Ill.

Published by the American Medical Association, 535 N. Dearborn Ave., Chicago 10, Ill.

POSTMASTER: Send address changes in U.S.A. to JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, 535 N. Dearborn Ave., Chicago 10, Ill.

ALTITUDE OBSERVATION OF THE SUN FOR AZIMUTH

(From the central pair of series)
(observed by equal altitude method)

Vertical angle to sun's lower limb	34° 40' 00"
Reduction to sun's center	+ 15 53
Refraction ((6000 ft.)	- 1 8
Parallax	+ 8

Sun's center h 34° 54' 53"

Sun's declination a. m. obsn. 7° 48' .8 N.
p. m. obsn. 7° 42' .5 N.

A. M. obsn.

P. M. obsn.

Nat sin 7° 48' .8 .13594
" cos 38 52 .4 .77854
" cos 34 54 .9 .82001

Nat sin 7° 42' .5 .13413

Nat tan 38 52 .4 .80613
" tan 34 54 .9 .69800

.13594
.77854 x .82001 - .80613 x .69800

+ .21294
- .52268

Cos A = .34974
A S. 69° 31' 42" E.

.13413
.77854 x .82001 - .80613 x .69800

+ .21010
- .52268

Cos A = .35298
A S. 69° 21' 18" W.

Deflection angle from reference point to NNE.:
104° 36' 30"

117° 5' 30"

Reduction to sun's center $\frac{15.9'}{\cos 34^\circ 55'}$
- 19' 24"

- 19' 24"

Horizontal angle to sun's center:

104° 17' 06" to E.

116° 45' 06" to W.

Sun's azimuth as computed:

S. 69° 31' 42" E.

S. 69° 21' 18" W.

True bearing of reference point:

N. 173° 48' 48" E.

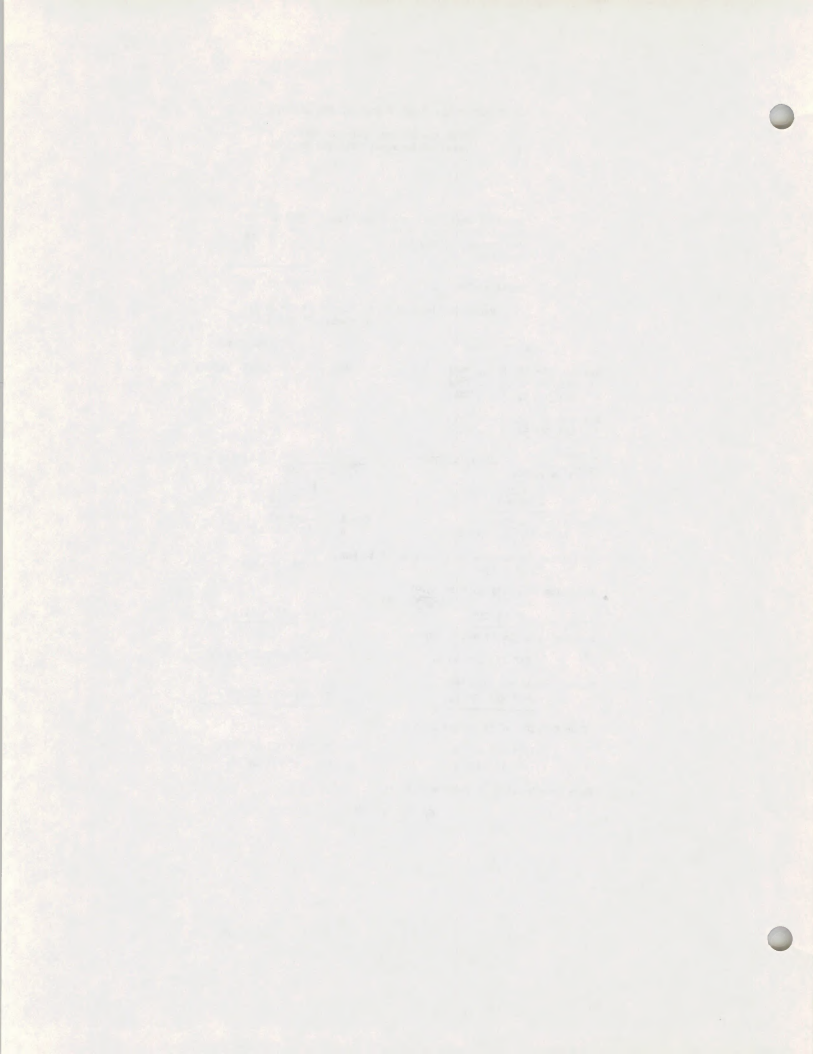
N. 186° 07' 24" W.

N. 6° 11' 12" E.

N. 6° 07' 24" E.

Mean true bearing of reference point:

N. 6° 09' 18" E.



EQUAL ALTITUDE OBSERVATION OF THE SUN FOR AZIMUTH

Date: Sept. 22, 1944

Observer: A.W. Proctor
Recorder: T.W. Crawford
Timer: T.W. CrawfordInstrument: Baffle
23615

FINAL FIELD NOTES

Sept. 22, 1944, at the G.L.C. instrument testing station on the U.S. post-office roof, Denver, Colo., in latitude $39^{\circ} 44' 56''$ N., longitude $104^{\circ} 50' 22.6''$ W., with elevation approx. 5,200 ft. and temp. approx. 70° F., between 10h 24m a.m. and 3h 17m. p.m., r.w.t., I make a series of three equal altitude observations upon the sun for azimuth, reading the horizontal deflection angles from a point in the letter "R" of hotel sign "KESMARK", about 20 chs. to the SOUTH, SE. in a.m. to the sun's right limb and SW. in p.m. to the sun's left limb, equal vertical angles being taken to the sun's lower limb.

Observation	Sun	Watch time, m.r.t.	Vertical angle	Horizontal angle flag to sun.
1st a.m.	$\frac{+}{-}$	10h 24m 04s	$37^{\circ} 34' 00''$	$49^{\circ} 51' 00''$ to SE.
3rd p.m.	$\frac{+}{-}$	3h 22m 27s	"	$49^{\circ} 42' 00''$ to SW.
				$0^{\circ} 09' 00''$ (Diff.)
2nd a.m.	$\frac{+}{-}$	10h 26m 50s	$37^{\circ} 59' 00''$	$40^{\circ} 09' 00''$ to SE.
2nd p.m.	$\frac{+}{-}$	3h 19m 38s	"	$40^{\circ} 59' 00''$ to SW.
sum of hr. angles		4h 52m 48s		$0^{\circ} 10' 00''$ (Diff.)
mean hour angle		2h 26m 24s		
3rd a.m.	$\frac{+}{-}$	10h 29m 42s	$38^{\circ} 24' 00''$	$48^{\circ} 23' 00''$ to SE.
1st p.m.	$\frac{+}{-}$	3h 16m 49s	"	$48^{\circ} 14' 30''$ to SW.
				$0^{\circ} 08' 30''$ (Diff.)

One-half differences, or bearing angles for uncorrected south point of flag.

By 1st observation $0^{\circ} 04' 30''$
 By 2nd observation $0^{\circ} 05' 00''$
 By 3rd observation $0^{\circ} 04' 15''$
 Mean $0^{\circ} 04' 35''$

Differential azimuth correction(-) $5' 12''$
 Mean true bearing of flag $S. 0^{\circ} 0' 29''$ E.

FIELD RECORD

The hourly change in the sun's declination $0' 58.41''$ S.
 The following computation is made to obtain the differential azimuth correction for the above series. The reduction is made by the following equation, where Δd and dA are each expressed in seconds:

$$\Delta d = \frac{\Delta \delta}{\cos \beta \sin \frac{1}{2}(t+\tau)}$$

$$\Delta \delta = \frac{1}{2} \times 4.88 \times 58.41 = 143'' \quad \log \Delta \delta = 2.155336$$

$$\beta = 39^{\circ} 44' 56'' \text{ P., } \log \cos \beta = 9.885844$$

$$\frac{1}{2}(t+\tau) = 2h 26m 24s = 76^{\circ} 36' 00''; \log \sin \frac{1}{2}(t+\tau) = 9.775410$$

$$\frac{143}{9.661254} = 2.494082$$

$$\log \Delta d = 2.494082$$

$$\Delta d = \text{Differential azimuth correction} = 312'' = 5' 12''$$

The following reduction to obtain the value of the differential azimuth correction is made with the use of Table 22 of the Standard Field Tables.

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

NAME	ADDRESS	CITY	STATE	ZIP
JOHN DOE	1234 MAIN ST	CHICAGO	IL	60601
JANE SMITH	5678 PINE ST	CHICAGO	IL	60602
BOB JONES	9010 OAK ST	CHICAGO	IL	60603
ALICE BROWN	2345 MAPLE ST	CHICAGO	IL	60604
CHARLIE WHITE	6789 BIRCH ST	CHICAGO	IL	60605
DAVID GREEN	1011 CYPRESS ST	CHICAGO	IL	60606
EMILY BLACK	4321 HICKORY ST	CHICAGO	IL	60607
FRED BROWN	7654 WALNUT ST	CHICAGO	IL	60608
GRACE WHITE	0987 PINE ST	CHICAGO	IL	60609
HELEN GREEN	3210 OAK ST	CHICAGO	IL	60610

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

THE UNIVERSITY OF CHICAGO

DEPARTMENT OF PHYSICS

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

THE UNIVERSITY OF CHICAGO

DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF PHYSICS
 530 SOUTH EAST ASIAN AVENUE
 CHICAGO, ILLINOIS 60607-7080
 TEL: 773/936-5000 FAX: 773/936-5001
 WWW: WWW.PHYSICS.UCHICAGO.EDU

Latitude	$\frac{1}{2}(t_1 + t_2)$ or hours from noon		
	2h	2h 26m 24s	3h
35°	2.44	2.05	1.73
39°44'56"		2.18	
40°	2.61	2.19	1.85

Declination coefficient 2.18

$dA\delta = 2.18 \times \frac{1}{2}dc = 2.18 \times 143'' = 312''$

$dA\delta = \text{differential azimuth correction} = 5.12''$

(This checks with the d.s.c. as computed by formula)

The 2nd a.m. and p.m. observations of the above sunrise are selected for an example of the reduction to the sun's center and direct computation of the sun's azimuth, and true bearing of the flag by the equations:

$$\cos A = \frac{\sin h}{\cos \delta \cos h} \quad \tan \delta \tan h$$

Vertical angle to sun's lower limb 37° 59' 00"
 Reduction to sun's center + 15' 58"
 Parallax + "
 Refraction - 1' 00"
 h: elev. of sun's center = 38° 14' 05"

Declination of the sun, Gr. app. noon 0° 15' 44.8" N.

Difference in time to a.m. obsn.

For longitude 6h 59m 58s

For time, a.m. 2h 26m 24s

4.44h = 4h 26m 22s

Change in decl. to app. time of a.m. obsn.

4.44 × 58.41 = 259" = 4' 19" S.

Sun's decl., a.m. obsn. 0° 11' 25" N.

11' 25" N.

Diff. to p.m. obsn. already computed: (2 × 143) × 286" = 4m 46s S.

Sun's decl., p.m. obsn. 0° 6' 40" N.

log cos δ 9.885844 ; log sin δ 7.521898 (+) log sin δ 7.287675 (+)
 log cos h 9.895137

9.780981	9.780981	9.780981
log tan δ 9.919045	log 7.740917	log 7.506554
log tan h 9.896474	nat. (+) .00551	nat. (+) .00321
log 9.816419		
nat. (-) .65527	(-) .65527	(-) .65527

One A = (-) .64976 (-) .65206

A = true bearing of sun 3. 49° 28' 35" E. S. 49° 18' 11" W.

Horizontal angles from flag to sun's right and left limbs:
 49° 09' 00" to SE 48° 59' 00" to SW.

Reduction to sun's center $\frac{15.97}{\cos \delta \times 14' 05''} = 20' 20''$ 20' 20"

Hor. angle to sun's center 49° 29' 20" 49° 19' 20"

Sun's azimuth as computed above:
 S. 49° 28' 35" E. S. 49° 18' 11" W.

True bearing of flag S. 0° 0' 45" E. S. 0° 1' 9" E.

Mean true bearing of flag S. 0° 0' 57" E.

By above direct computation A: a.m., 49° 28' 35"
 A: p.m., 49° 18' 11"

Difference $2dA\delta = 10' 24''$

$dA\delta = 5.12''$

This value $dA\delta$ agrees with the same function as computed by the two previous methods.

THE UNIVERSITY OF CHICAGO PRESS

CHICAGO, ILLINOIS 60607

1980

1981

1982

1983

1984

1985

1986

1987

1988

1989

1990

1991

1992

1993

1994

1995

1996

1997

1998

One-half differences of horizontal angles, or bearings of reference point, and watch time of star's transit.

	Bearing of reference point	Watch time of star's transit
By 1st obsn.	= N. 27° 05' 45" E.	0 ^h 09 ^m 15 ^s a.m.
" 2nd "	= N. 27 06 15 E.	0 09 14 " "
" 3rd "	= N. 27 06 00 E.	0 09 15 " "
" 4th "	= N. 27 05 45 E.	0 09 13 " "
Mean bearing of reference point	= N. 27° 05' 56" E.	Mean watch t., star's transit, Oct. 27 0 ^h 09 ^m 14 ^s a.m.
		Red. to Oct. 26 +12
		Star's transit, p.m.,
		l.m.t., Oct. 26 11 ^h 41 ^m 06 ^s
		Watch fast of l.m.t. 0 ^h 28 ^m 08 ^s

Meridian altitude observation of the star for latitude.

Watch time of star's transit, Oct. 27, 0^h 09^m 14^s a.m.

$$\begin{array}{r}
 \text{Settings:} \quad 90^\circ 00' \\
 \delta \quad 23 \quad 12 \\
 90^\circ + \delta \quad 113^\circ 12' \\
 \delta \quad 40 \quad 45 \\
 \hline
 \therefore \quad 72^\circ 27' = (90^\circ + \delta) - \delta
 \end{array}$$

Telescope	Watch time	Vertical angle
Direct	0 ^h 05 ^m 16 ^s a.m.	72° 23' 00"
Reversed	0 07 35 " "	72 27 00
Direct	0 11 22 " "	72 29 00
Reversed	0 14 42 " "	72 26 00
Mean	0 ^h 09 ^m 59 ^s a.m.	72° 27' 30"
Refraction in zenith distance =	19" x .85 (coefficient for elevation of 4900 feet)	- 16"
$\delta = 23^\circ 12' 06''; 90^\circ + \delta$		$h = 72^\circ 27' 14''$ <u>-113 12 06</u>
Latitude = 40° 44' 52" N. = (90° + δ) - h		= 40° 44' 52"

Q - 2

Stellar Equal Altitude Observation for
Time, Azimuth and Latitude.

Date: November 8, 1944

Observer: Quintin Campbell

Instrument: Buff No. 23829.

Recorder: Roger F. Wilson

Time : Charles E. Hunter

Selected Star: 27/54 1.3

= Piscis Australis (Fomalhaut)

- 29° 55.05'

At observing station near the center of sec. 36, T. 1 N., R. 8 E., S. B. M., California, in latitude 34° 07.6' N., and longitude 116° 06' W., I make a series of six equal altitude observations on the star for time and azimuth, reading the horizontal deflection angle to the left and to the right of an illuminated flag, about 15 chs. S. and E. of my station. The star is also observed at its maximum elevation for vertical angle to obtain the latitude of the station.

Observation.	Watch time.	Vertical angle	Horizontal angle (Flag to star)
1.	6h 05m 57s p.m.	23° 13'	13° 24' 00" to SE.
12.	8 47 08		24° 37' 00" to SW.
			11° 13' 00" (Diff.)
2.	6h 10m 51s	23° 31'	12° 18' 30" to SE.
11.	8 42 12		23° 31' 30" to SW.
			11° 13' 00" (Diff.)
3.	6h 15m 40s	23° 50'	11° 12' 30" to SE.
10.	8 37 25		22° 25' 30" to SW.
			11° 13' 00" (Diff.)
4.	6h 20m 38s	24° 06' 30"	10° 05' 30" to SE.
9.	8 32 28		21° 18' 30" to SW.
			11° 13' 00" (Diff.)
5.	6h 25m 20s	24° 22'	8° 59' 30" to SE.
8.	8 27 42		20° 12' 30" to SW.
			11° 13' 00" (Diff.)
6.	6h 30m 23s	24° 26'	7° 49' 30" to SE.
7.	8 22 41		19° 02' 30" to SW.
			11° 13' 00" (Diff.)

One-half differences, or bearing angles from South point to flag.

By 1st obsn.	=	S. 5° 36' 30" E.
" 2nd "	"	" " "
" 3rd "	"	" " "
" 4th "	"	" " "
" 5th "	"	" " "
" 6th "	"	" " "

Mean true bearing to flag - S. 5° 36' 30" E.

Time.

Mean of watch readings; obsns. 1 to 6	:	6h 18m 08s p.m.
Mean of watch readings; obsns. 7 to 12	:	<u>8h 34m 56s</u>
Sum	:	14h 52m 64s
$\frac{1}{2}$ sum; Watch time of transit of Star	:	7h 26m 32s p.m.

Greenwich mean time; star's transit Nov. 1	:	8h 11m p.m.
Reduced to Nov. 8	:	- 27.5
Reduced to longitude 116° 06' W.	:	<u>- 1.3</u>
Star's transit, l.m.t.	:	7h 42.2m p.m.
Longitude correction to Pac. Standard Time	:	<u>- 15.6</u>
Star's transit, P. S. T.	:	<u>7h 26.6m</u>
Observed P. S. T. of Star's transit	:	<u>7h 26.5m</u>
Watch slow of Pacific Standard Time	:	0.1m

Latitude.

Observed altitude, direct	:	25° 58' 30"
, reversed	:	<u>26° 00' 00"</u>
Mean observed altitude	:	v = 25° 59' 15"
Refraction	:	r = - 0° 1' 58"
True vertical angle	:	h = 25° 57' 17"
Star's declination	:	δ = 29° 55' 03" S.
Sum	:	= 55° 52' 20"
Latitude:	:	ϕ = 90° - h \pm δ
	:	90° 00' 00"
	:	- 55° 52' 20"
Reduced latitude :	:	<u>ϕ = 34° 07' 40" N.</u>

Time

Mean of three readings: 1 to 0 : 60.100 0.2 p.m.
 Mean of three readings: 1 to 11 : 60.100 0.2 p.m.
 Mean : 60.100 0.2 p.m.
 5 feet water level at transit of star : 60.100 0.2 p.m.

Observed time of star's transit (local)	60.100 0.2 p.m.
Reduced to 11° 00' W.	60.100 0.2 p.m.
Reduced to 11° 00' W.	60.100 0.2 p.m.
Star's position, 11.1	60.100 0.2 p.m.
Longitude correction to 11.1	60.100 0.2 p.m.
Star's position, 11.1	60.100 0.2 p.m.
Reduced to 11.1 of star's position	60.100 0.2 p.m.
Mean time of star's transit	60.100 0.2 p.m.

Latitude

Observed altitude, direct : 50° 52' 30"
 Reduced to 11° 00' W. : 50° 52' 30"
 Mean observed altitude : 50° 52' 30"
 Reduction : 0° 0' 0"
 True vertical angle : 50° 52' 30"
 Star's declination : 50° 52' 30"
 Sum : 50° 52' 30"
 Latitude : 50° 52' 30"
 Reduced latitude : 50° 52' 30"
 50° 52' 30"
 50° 52' 30"
 50° 52' 30"

Example of direct altitude observation of the sun for azimuth and time, sun south declination:

Date: November 9, 1944.

Instrument: Buff No. 14187.

Observer: George W. Johnson

Recorder: Ray W. Garrett.

Collimator test of vertical circle, Sept. 5, 1944:

Telescope direct, sights OK at zero	0° 00' 00"
Telescope reversed, sights high at zero	0 01 00
Mean index correction at zero	- 0' 30"
At true vertical angle	+40° 00' 00"
Mean corrected value	+40 00 30
Mean index correction	- 0' 30"
	0° 00'

Transcribed field notes.

Nov. 9, 1944, at my station on the random line between secs. 13 and 14, T. 1 S., R. 27 W., 5th Prin. Mer., Arkansas, in latitude 34° 39' 37" N., and longitude 93° 50' W., elevation above sea level approximately 1000 ft., and temperature approximately 40° F., at 8h 56m a.m. app. time, in order to verify the adjustments of the solar unit, I make a series of three altitude observations of the sun for azimuth, each with the telescope in direct and reversed positions, observing opposite limbs of the sun, and reading the horizontal angle from a flag on my retracement line set by solar transit orientation S. 0° 40' W., 88. to the sun. My watch carries approximate apparent time.

Observation.	Telescope.	Sun.	Watch time.	Observed vertical angle.	Horizontal angle, flag to sun.
1st "	Direct	q b	8h 56m 00s	22° 43' 00"	49° 03' 00"
	Reversed		8 57 00	22 18 00	48 15 00
	Mean		8h 56m 30s	22° 30' 30"	48° 39' 00"
2nd "	Reversed	q b	8h 57m 30s	22° 57' 00"	48° 42' 00"
	Direct		8 58 30	22 34 00	47 57 00
	Mean		8h 58m 00s	22° 45' 30"	48° 19' 30"
3rd "	Direct	q b	8h 59m 00s	23° 15' 00"	48° 21' 00"
	Reversed		9 01 00	22° 50 00	47 33 00
	Mean		9h 00m 00s	23° 02' 30"	47° 57' 00"

By 1st obsn. flag bears S. 0° 39' 41" W.
 " 2nd " " " S. 0 39 53 W.
 " 3rd " " " S. 0 39 57 W.

Mean, true bearing of flag S. 0° 39' 50" W.

Watch fast of 1 m.t., by 2nd obsn. 15m 57s

Field record.

The declination of the sun for the mean period of the three observations = 16° 56' 38" S.

The following reductions are made to obtain the true vertical angles of the above observations:

	1st obsn.	2nd obsn.	3rd obsn.
v =	22° 30' 30"	22° 45' 30"	23° 02' 30"
Transit index correction	- 0 30	- 0 30	- 0 30
Refraction (Coef. : .98 x 1.02 = 1.00) ..	- 2 19	- 2 17	- 2 15
Sun's parallax	+ 8	+ 8	+ 8
h =	22° 27' 49"	22° 42' 51"	22° 59' 53"

The above observations are reduced for azimuth by the equations:

$$\cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h$$

The function "sin δ " becomes negative for south declinations.

1st obsn.:

$$\phi = 34^{\circ} 39' 37'' \quad h = 22^{\circ} 27' 19'' \quad \delta = 16^{\circ} 56' 38''$$

$$\begin{array}{rcl} \cos \phi = .822539 & \sin \delta = -.291135 & \tan \phi = .691108 \\ \cos h = .924122 & & \tan h = .413470 \\ \hline .760126 & .760126 & -.285876 \\ & -.383404 & -.383404 \end{array}$$

$$\cos A = -.669280$$

$$A = S. 47^{\circ} 59' 19'' E.$$

$$\text{Hor. ang.} = 48 \quad 39 \quad 00$$

$$\text{Bearing of flag} = S. \quad 0^{\circ} 39' 41'' W.$$

2nd obsn.:

$$h = 22^{\circ} 42' 51''$$

$$\begin{array}{rcl} \cos \phi = .822539 & \sin \delta = -.291135 & \tan \phi = .691108 \\ \cos h = .922443 & & \tan h = .418600 \\ \hline .758746 & .758746 & -.289423 \\ & -.384101 & -.384101 \end{array}$$

$$\cos A = -.673524$$

$$A = S. 47^{\circ} 39' 37'' E.$$

$$\text{Hor. ang.} = 48 \quad 19 \quad 30$$

$$\text{Bearing of flag} = S. \quad 0^{\circ} 39' 53'' W.$$

3rd obsn.:

$$h = 22^{\circ} 59' 53''$$

$$\begin{array}{rcl} \cos \phi = .822539 & \sin \delta = -.291135 & \tan \phi = .691108 \\ \cos h = .920518 & & \tan h = .424435 \\ \hline .757162 & .757162 & -.293458 \\ & -.384904 & -.384904 \end{array}$$

$$\cos A = -.678362$$

$$A = S. 47^{\circ} 17' 03'' E.$$

$$\text{Hor. ang.} = 47 \quad 57 \quad 00$$

$$\text{Bearing of flag} = S. \quad 0^{\circ} 39' 57'' W.$$

The second observation is reduced for time by the equation:

$$\cos t = \frac{\sin h}{\cos \phi \cos \delta} - \tan \phi \tan \delta$$

The product "tan ϕ tan δ " is additive for south declinations.

$$\begin{array}{rcl} \cos \phi = .822539 & \sin h = .386134 & \tan \phi = .691108 \\ \cos \delta = .956591 & & \tan \delta = .304660 \\ \hline .786833 & .786833 & .201644 \\ & .490745 & .490745 \end{array}$$

$$\cos t = .701381$$

$$t = 45^{\circ} 27' 41''$$

$$= 3h \quad 1m \quad 51s$$

$$\text{App. time} = 8h \quad 58m \quad 09s \quad \text{A.M.}$$

$$\text{Equation of time} = -16 \quad 06$$

$$\text{L.m.t. of obsn.} = 8h \quad 42m \quad 03s \quad \text{A.M.}$$

$$\text{Watch time of obsn.} = 8 \quad 58 \quad 00 \quad \text{A.M.}$$

$$\text{Watch fast of l.m.t.} = 15m \quad 57s$$

The first of the above series is selected for an example of reduction for azimuth by the equation:

$$\cos \frac{1}{2} A = \frac{\sin S \sin (S - \text{codeo.})}{\sin \text{colat.} \sin \text{coalt.}}$$

$$\begin{aligned} 90^\circ - \beta &= 90^\circ - 34^\circ 39' 37'' = 55^\circ 20' 23'' = \text{colat.} \\ 90^\circ - \delta &= 90^\circ - (-16^\circ 56' 38'') = 106^\circ 56' 38'' = \text{codeo.} \\ 90^\circ - h &= 90^\circ - 22^\circ 49' 12'' = 67^\circ 32' 11'' = \text{coalt.} \end{aligned}$$

$$\begin{aligned} 2S &= 229^\circ 49' 12'' \\ S &= 114^\circ 54' 36'' \\ \text{Codeo.} &= 106^\circ 56' 38'' \end{aligned}$$

$$S - \text{codeo.} = 7^\circ 57' 58''$$

$$\begin{aligned} \log \sin S & 9.957593 \\ \log \sin (S - \text{codeo.}) & 9.141724 \\ \log & 9.099317 \end{aligned}$$

$$\begin{aligned} \log \sin \text{colat.} & 9.915156 \\ \log \sin \text{coalt.} & 9.965729 \end{aligned}$$

$$\log 9.880885 \quad 9.880885$$

$$\begin{aligned} \log \cos^2 \frac{1}{2} A &= 9.218432 \\ \log \cos \frac{1}{2} A &= 9.609216 \\ \frac{1}{2} A &= 66^\circ 00' 21'' \\ A &= N. 132^\circ 00' 42'' E. \\ &= S. 47^\circ 59' 18'' E. \\ \text{Hor. ang.} &= 48^\circ 39' 00'' \end{aligned}$$

$$\text{Bearing of flag} = S. 0^\circ 39' 42'' W.$$

The second of the above series is selected for an example of reduction for azimuth by the equation:

$$\tan \frac{1}{2} A = \frac{\cos \frac{1}{2} (\epsilon + \beta + \delta) \sin \frac{1}{2} (\epsilon - \beta - \delta)}{\cos \frac{1}{2} (\epsilon - \beta - \delta) \sin \frac{1}{2} (\epsilon + \beta + \delta)}$$

$$\begin{aligned} 90^\circ 00' 00'' \\ h = 22^\circ 42' 51'' \end{aligned}$$

$$\begin{aligned} \epsilon &= 67^\circ 17' 09'' \\ \beta &= 34^\circ 39' 37'' \end{aligned} \quad \begin{aligned} \epsilon &= 67^\circ 17' 09'' \\ \beta &= 34^\circ 39' 37'' \end{aligned}$$

$$\begin{aligned} \epsilon + \beta &= 101^\circ 56' 46'' \\ \delta &= 16^\circ 56' 38'' (-) \end{aligned} \quad \begin{aligned} \epsilon - \beta &= 32^\circ 37' 32'' \\ \delta &= 16^\circ 56' 38'' (-) \end{aligned}$$

$$\begin{aligned} \epsilon + \beta + \delta &= 85^\circ 00' 08'' \\ \frac{1}{2}(\epsilon + \beta + \delta) &= 42^\circ 30' 04'' \end{aligned} \quad \begin{aligned} \epsilon - \beta + \delta &= 15^\circ 40' 54'' \\ \frac{1}{2}(\epsilon - \beta + \delta) &= 7^\circ 50' 27'' \end{aligned}$$

$$\begin{aligned} \epsilon + \beta &= 101^\circ 56' 46'' \\ \delta &= 16^\circ 56' 38'' (-) \end{aligned} \quad \begin{aligned} \epsilon - \beta &= 32^\circ 37' 32'' \\ \delta &= 16^\circ 56' 38'' (-) \end{aligned}$$

$$\begin{aligned} \epsilon + \beta - \delta &= 118^\circ 53' 24'' \\ \frac{1}{2}(\epsilon + \beta - \delta) &= 59^\circ 26' 42'' \end{aligned} \quad \begin{aligned} \epsilon - \beta - \delta &= 49^\circ 34' 10'' \\ \frac{1}{2}(\epsilon - \beta - \delta) &= 24^\circ 47' 05'' \end{aligned}$$

$$\begin{aligned} \log \cos \frac{1}{2}(\epsilon + \beta + \delta) & 9.867623 \\ \log \sin \frac{1}{2}(\epsilon + \beta + \delta) & 9.935075 \end{aligned}$$

$$9.802698$$

$$\begin{aligned} \log \cos \frac{1}{2}(\epsilon - \beta - \delta) & 9.958033 \\ \log \sin \frac{1}{2}(\epsilon - \beta - \delta) & 9.134873 \\ & 9.092906 \end{aligned}$$

$$9.092906$$

$$\begin{aligned} \log \tan^2 \frac{1}{2} A & 0.709792 \\ \log \tan \frac{1}{2} A & 0.354896 \\ \frac{1}{2} A & 66^\circ 10' 12'' \\ A & N. 132^\circ 20' 24'' E. \\ & S. 47^\circ 39' 36'' E. \end{aligned}$$

$$\text{Hor. angle} = 48^\circ 19' 30''$$

$$\text{Bearing of flag} = S. 0^\circ 39' 54'' W.$$

The second of the above series is likewise selected for an example of reduction for time by the equation:

$$\tan \frac{1}{2} t = \sqrt{\frac{\sin \frac{1}{2} (t+\phi-\delta)}{\cos \frac{1}{2} (t+\phi-\delta)} \frac{\sin \frac{1}{2} (t-\phi-\delta)}{\cos \frac{1}{2} (t-\phi-\delta)}}$$

$$\begin{array}{r} \log \sin \frac{1}{2} (t+\phi-\delta) \\ \log \sin \frac{1}{2} (t-\phi-\delta) \end{array} \quad \begin{array}{r} 9.935075 \\ 9.134873 \end{array}$$

$$\begin{array}{r} \log \cos \frac{1}{2} (t+\phi-\delta) \\ \log \cos \frac{1}{2} (t-\phi-\delta) \end{array} \quad \begin{array}{r} 9.867683 \\ 9.958033 \end{array}$$

$$\begin{array}{r} 9.825656 \\ 9.885656 \end{array}$$

$$\begin{array}{r} \log \tan^2 \frac{1}{2} t \\ \log \tan \frac{1}{2} t \\ \frac{1}{2} t \end{array} \quad \begin{array}{r} = 9.244292 \\ = 9.622146 \\ = 22^\circ 13' 50'' \\ = 15^\circ 27' 40'' \\ = 3^h 01^m 51^s \end{array}$$

$$\begin{array}{r} \text{App. time of observation} \\ \text{Equation of time} \end{array} \quad \begin{array}{r} = 8^h 58^m 09^s \text{ a.m.} \\ = -16 \quad 06 \end{array}$$

$$\begin{array}{r} \text{L.m.t. of observation} \\ \text{Watch time of observation} \end{array} \quad \begin{array}{r} = 8^h 42^m 03^s \text{ a.m.} \\ = 8 \quad 58 \quad 00 \text{ a.m.} \end{array}$$

$$\text{Watch fast of l.m.t.} = \underline{15^m 57^s}$$

The second of the above series is likewise selected for an example of reduction for time by the equation:

$$\sin t = \frac{\sin A \cos h}{\cos \delta}$$

$$A = 47^\circ 39' 37'' \quad h = 22^\circ 42' 51'' \quad = 16^\circ 56' 38''$$

$$\begin{array}{r} \log \sin A = 9.868741 \\ \log \cos h = 9.964939 \end{array}$$

$$\begin{array}{r} 9.833680 \\ \log \cos \delta = 9.980726 \end{array}$$

$$\begin{array}{r} \log \sin t = 9.852954 \\ t = 15^\circ 27' 41'' = 3^h 01^m 51^s \end{array}$$

$$\begin{array}{r} \text{Apparent time of observation} \\ \text{Equation of time} \end{array} \quad \begin{array}{r} = 8^h 58^m 03^s \text{ a.m.} \\ = -16 \quad 06 \end{array}$$

$$\begin{array}{r} \text{Local mean time of observation} \\ \text{Watch time of observation} \end{array} \quad \begin{array}{r} = 8^h 42^m 03^s \text{ a.m.} \\ = 8 \quad 58 \quad 00 \text{ a.m.} \end{array}$$

$$\text{Watch fast of local mean time} = \underline{15^m 57^s}$$

Note: This equation is not recommended for hour angles approaching 90° or 6 hours, as the sine function changes very slowly for angles approaching 90° .

Date:
October 21, 1944.
Time: 1.m.t.




Observer:
E. D. Calvin

Instrument:
Buff No. 19422.

Example of direct altitude observation of the sun for azimuth and time,
sun south declination:

Transcribed field notes.

October 21, 1944, at a transit point in Boise, Idaho, in latitude $43^{\circ} 37' 13''$ N., and longitude $116^{\circ} 12'$ W., altitude above sea level approximately 2700 ft., and temperature approximately 50° F., at $8^h 27^m$ a.m., app. time, I make a series of three altitude observations of the sun for azimuth, each with the telescope in direct and reversed positions, observing opposite limbs of the sun, and reading the horizontal angle from depot cupola, designated as flag, about 60 obs. to the SW., to the left to the sun. My watch carries approximate local mean time.

Observation.	Telescope.	Sun.	Watch time.	Observed vertical angle.	Horizontal angle, flag to sun.
1st "	Direct		$8^h 11^m 15^s$	$17^{\circ} 29' 00''$	$88^{\circ} 28' 00''$
	Reversed		$8 12 19$	$17 08 30$	$88 46 00$
	Mean		$8^h 11^m 47^s$	$17^{\circ} 18' 45''$	$88^{\circ} 37' 00''$
2nd "	Direct		$8^h 13^m 07^s$	$17^{\circ} 48' 00''$	$88^{\circ} 03' 00''$
	Reversed		$8 14 29$	$17 28 30$	$88 16 00$
	Mean		$8^h 13^m 48^s$	$17^{\circ} 38' 15''$	$88^{\circ} 09' 30''$
3rd "	Direct		$8^h 15^m 40^s$	$18^{\circ} 13' 00''$	$87^{\circ} 27' 00''$
	Reversed		$8 16 50$	$17 53 30$	$87 43 00$
	Mean		$8^h 16^m 15^s$	$18^{\circ} 03' 15''$	$87^{\circ} 35' 00''$

By 1st obsn. flag bears $S. 33^{\circ} 12' 06''$ W.

By 2nd obsn. flag bears $S. 33^{\circ} 11' 32''$ W.

By 3rd obsn. flag bears $S. 33^{\circ} 12' 01''$ W.

Mean, true bearing of flag $S. 33^{\circ} 11' 53''$ W.

Watch slow of 1.m.t., 2nd obsn. = 22"

Field record.

The declination of the sun for the mean period of the three observations is $10^{\circ} 48' 49''$ S.

The following reductions are made to obtain the true vertical angles of the above observations:

	1st obsn.	2nd obsn.	3rd obsn.
γ	$17^{\circ} 18' 45''$	$17^{\circ} 38' 15''$	$18^{\circ} 03' 15''$
Refraction (Coef. = .92)	$- 2 48$	$- 2 46$	$- 2 42$
Parallax	$+ 8$	$+ 8$	$+ 8$
h	<u>$17^{\circ} 16' 05''$</u>	<u>$17^{\circ} 35' 37''$</u>	<u>$18^{\circ} 00' 41''$</u>

The above observations are reduced for azimuth by the equation:

$$\cos A = \frac{\sin \delta}{\cos \varphi \cos h} - \tan \varphi \tan h$$

The function "sin δ " becomes negative for south declinations.

1st obsn.:					
log cos φ	9.859695	log sin δ	9.273267	log tan φ	9.979076
" " h	9.979970			" " h	9.492556
log	9.839665		9.839665	log	9.471632
		log	9.433602	nat -	.296232
		nat	.271395	" -	.271395
				Cos A -	.567627

True bearing of sun, A S. 55° 24' 54" E.
 Hor. ang., flag to sun 88 37 00

True bearing of flag S. 33° 12' 06" W.

2nd obsn.:					
log cos φ	9.859695	log sin δ	9.273267	log tan φ	9.979076
" " h	9.979195			" " h	9.501191
log	9.838890		9.838890	log	9.480267
		log	9.434377	nat -	.302181
		nat -	.271880	" -	.271880
				Cos A -	.574061

True bearing of sun, A S. 54° 57' 58" E.
 Hor. ang., flag to sun 88 09 30

True bearing of flag S. 33° 11' 32" W.

3rd obsn.:					
log cos φ	9.859695	log sin δ	9.273267	log tan φ	9.979076
" " h	9.978178			" " h	9.512070
log	9.837873		9.837873	log	9.491146
		log	9.435394	nat -	.309846
		nat -	.272517	" -	.272517
				Cos A -	.582362

True bearing of sun, A S. 54° 22' 59" E.
 Hor. ang., flag to sun 87 35 00

True bearing of flag S. 33° 12' 01" W.

The second observation is reduced for time by the equation:

$$\cos t = \frac{\sin h}{\cos \varphi \cos \delta} - \tan \varphi \tan \delta$$

The product "tan φ tan δ " is additive for south declinations.

log cos φ	9.859695	log tan φ	9.979076
" " δ	9.992219	" " δ	9.281048
log	9.851914	log	9.260124
		nat +	.182022

$$\begin{aligned}\log \sin h &= 9.480386 \\ \log (\cos \varphi \cos \delta) &= 9.851914 \\ \log &= 9.628472 \\ \text{nat} + &= .425081 \\ \tan \varphi \tan \delta + &= .182022\end{aligned}$$

$$\cos t = .607103$$

$$\begin{aligned}t = 52^\circ 37' 11'' &= 3^h 30^m 29^s = 8^h 29^m 31^s \text{ a.m.} \\ \text{Equation of time} &= -15 \text{ } 21 \\ \text{L.m.t. of observation} &= 8^h 14^m 10^s \text{ a.m.} \\ \text{Watch time of observation} &= 8 \text{ } 13 \text{ } 48 \text{ a.m.} \\ \text{Watch slow of l.m.t.} &= 22^s\end{aligned}$$

The first of the above series is selected for an example of reduction by the equation:

$$\cos \frac{1}{2} A = \sqrt{\frac{\sin \delta \sin (8 - \text{codeo.})}{\sin \text{colat.} \sin \text{coalt.}}}$$

$$\begin{aligned}90^\circ - \varphi &= 90^\circ - 43^\circ 37' 13'' = 46^\circ 22' 47'' = \text{colat.} \\ 90^\circ - \delta &= 90^\circ - (-10^\circ 48' 49'') = 100^\circ 48' 49'' = \text{codeo.} \\ 90^\circ - h &= 90^\circ - 17^\circ 16' 05'' = 72^\circ 43' 55'' = \text{coalt.} \\ 28 &= 219^\circ 55' 31'' \\ \delta &= 109^\circ 57' 45'' \\ \text{codeo.} &= 100^\circ 48' 49'' \\ 8 - \text{codeo.} &= 9^\circ 08' 56''\end{aligned}$$

$$\begin{aligned}\log \sin \delta &9.973089 \\ \log \sin (8 - \text{codeo.}) &9.201399\end{aligned}$$

$$\begin{aligned}\log \sin \text{colat.} &9.859695 \\ \log \sin \text{coalt.} &9.979970\end{aligned}$$

$$\log 9.174488$$

$$\log 9.839665$$

$$9.839665$$

$$\log \cos^2 \frac{1}{2} A$$

$$9.334823$$

$$\log \cos \frac{\delta}{2} A$$

$$9.667412$$

$$\log \cos \frac{\delta}{2} A$$

$$62^\circ 17' 33''$$

$$A$$

$$N. 124^\circ 35' 06'' E.$$

$$\text{True bearing of sun}$$

$$S. 55^\circ 24' 54'' E.$$

$$\text{Hor. ang. flag to sun}$$

$$88^\circ 37' 00''$$

$$\text{True bearing of flag}$$

$$S. 33^\circ 12' 06'' W.$$

The second of the above series is selected for an example of reduction by the equation:

$$\tan \frac{1}{2} A = \sqrt{\frac{\cos \frac{1}{2} (\zeta + \varphi + \delta) \sin \frac{1}{2} (\zeta - \varphi - \delta)}{\cos \frac{1}{2} (\zeta - \varphi - \delta) \sin \frac{1}{2} (\zeta + \varphi + \delta)}}$$

$90^{\circ}00'00''$	
$h = 17^{\circ}35'37''$	
$\zeta = 72^{\circ}24'23''$	$\zeta = 72^{\circ}24'23''$
$\varphi = 43^{\circ}37'13''$	$\varphi = 43^{\circ}37'13''$
$\zeta + \varphi = 116^{\circ}01'36''$	$\zeta - \varphi = 28^{\circ}47'10''$
$\delta = 10^{\circ}48'49''$ (-)	$\delta = 10^{\circ}48'49''$ (-)
$\zeta + \varphi + \delta = 105^{\circ}12'47''$	$\zeta - \varphi + \delta = 17^{\circ}58'21''$
$\frac{1}{2}(\zeta + \varphi + \delta) = 52^{\circ}36'23''$	$\frac{1}{2}(\zeta - \varphi + \delta) = 8^{\circ}59'10''$
$\zeta + \varphi = 116^{\circ}01'36''$	$\zeta - \varphi = 28^{\circ}47'10''$
$\delta = 10^{\circ}48'49''$ (-)	$\delta = 10^{\circ}48'49''$ (-)
$\zeta + \varphi - \delta = 126^{\circ}50'25''$	$\zeta - \varphi - \delta = 39^{\circ}35'59''$
$\frac{1}{2}(\zeta + \varphi - \delta) = 63^{\circ}25'12''$	$\frac{1}{2}(\zeta - \varphi - \delta) = 19^{\circ}47'59''$
$\log \cos \frac{1}{2}(\zeta + \varphi + \delta)$	9.783394
$\log \sin \frac{1}{2}(\zeta + \varphi + \delta)$	9.951488
	9.734082
$\log \cos \frac{1}{2}(\zeta - \varphi + \delta)$	9.973535
$\log \sin \frac{1}{2}(\zeta - \varphi + \delta)$	9.193667
	9.167202
	9.167202
$\log \tan^2 \frac{1}{2} A$	0.567680
$\log \tan \frac{1}{2} A$	0.283840
$\frac{1}{2} A$	62^{\circ}31'01''
A	125^{\circ}02'02'' E.
True bearing of sun	S. 54^{\circ}57'58'' E.
Hor.ang., flag to sun	88^{\circ}09'50''
True bearing of flag	S. 33^{\circ}11'32'' W.

The second of the above series is likewise selected for an example for the computation for time by the equation:

$$\tan \frac{1}{2} t = \sqrt{\frac{\sin \frac{1}{2} (\zeta + \varphi - \delta) \sin \frac{1}{2} (\zeta - \varphi - \delta)}{\cos \frac{1}{2} (\zeta + \varphi - \delta) \cos \frac{1}{2} (\zeta - \varphi - \delta)}}$$

$\log \sin \frac{1}{2} (\zeta + \varphi - \delta)$	9.951488
$\log \sin \frac{1}{2} (\zeta - \varphi - \delta)$	9.193667
	9.145155
$\log \cos \frac{1}{2} (\zeta + \varphi - \delta)$	9.783394
$\log \cos \frac{1}{2} (\zeta - \varphi - \delta)$	9.973535
	9.767929
	9.756929
$\log \tan^2 \frac{1}{2} t$	9.388226
$\log \tan \frac{1}{2} t$	9.694113
$\frac{1}{2} t$	26^{\circ}18'35''
t	52^{\circ}37'10'' = 3^h 30^m 29^s
Apparent time of observation	= 8^h 29^m 31^s a.m.
Equation of time	= -15 21
L.m.t. of observation	= 8^h 14^m 10^s a.m.
Watch time of observation	= 8 13 48 a.m.
Watch slow of local mean time	= 22^s

FOR TEST OF THE SOLAR UNIT

Basewood Lake, Minn. Latitude: $48^{\circ}03'30''N$. Longitude: $91^{\circ}30'35''W$.
 July 31, 1945. Arthur D. Kidder, Buff no. 19421
 District Cadastral Engineer, General Land Office
 observing and recording; watch read- solar transit.
 ing approximate local mean time.

July 31, 1945, at the camp site in sec. 33, T. 65 N., R. 9 W., 4th Prin. Mer., Minnesota, on the south shore of Basewood Lake in the International Boundary Waters, in latitude $48^{\circ}03'30''N$, and longitude $91^{\circ}30'35''W$, I examine the adjustments of General Land Office solar transit, Buff no. 19421, and find that no corrections are required.

July 31: I make an altitude observation on the sun, p.m., for time and azimuth; and a sunset hour angle observation on Polaris for latitude and azimuth. Aug. 1: at apparent noon, a meridian observation on the sun for time and latitude.

July 31: At $3^{h}54^{m}$ p.m., app.t., I set $48^{\circ}03'30''N$ on the lat. arc; $18^{\circ}13'N$ on the decl. arc; and orient to the meridian by observation with the solar unit. I find a suitable azimuth mark on the center of the west chimney of the main cabin of the Canadian Ranger Station, which bears $N.37^{\circ}03'30''E$, about 4 Mi. dist.

July 31: Altitude observation on the sun:

Tel.	Sun	Watch Time p.m.	Hor. Ang. NE-N-W-SW	Observed Vert. Ang.
Dir.	$\frac{C}{\perp}$	$4^h 22^m 30^s$	$133^{\circ}35'00''$	$30^{\circ}31'30''$
Rev.	$\frac{+}{\perp}$	$4^h 27^m 30^s$	$133^{\circ}12'00''$	$20^{\circ}13'30''$
Mean		$4^h 25^m 00^s$	$133^{\circ}23'30''$	$v = 30^{\circ}22'30''$ $r = -1^{\circ}39'$ $p = +08'$

Decl. = $18^{\circ}11'30''N$.h = $30^{\circ}21'$ $83^{\circ}40'00'' = A =$ Reduced azimuth of sun.

L.M.T.	$4^h 24^m 22^s$	$217^{\circ}03'30''$	Reduced app.t. of obsn. = $4^h 18^m 08^s$
	$- 180^{\circ}00'00''$	Equation of time	= $+6^m 14^s$
Watch fast	$0^m 38^s$	$N.37^{\circ}03'30''E$, = Indicated bearing of reference mark.	

July 31: Polaris at sunset:

Tel.	Watch Time p.m.	Hor. Ang. NE-N	Gr. U.C. Aug. 1 = $5^h 08.3^m$ a.m.	Observed Vert. Ang.
Dir.	$7^h 08^m 27^s$	$36^{\circ}19'00''$	Red. for long. = -1.40	
Rev.	$7^h 14^m 39^s$	$36^{\circ}17'30''$	U.C., l.m.t. = $5^h 07.3^m$ a.m.	$47^{\circ}11'00''$ $47^{\circ}12'00''$
Mean	$7^h 11^m 33^s$	$36^{\circ}18'15''$	Decl. = $88^{\circ}59'59''N$.	$v = 47^{\circ}11'30''$ $r = -0^{\circ}56'$ $h = 47^{\circ}10'34''$
Watch fast of l.m.t.	$0^m 38^s$		Vert. Ang. correction to elev. of pole, add	$0^{\circ}51'36''$
L.M.T.	$7^h 10^m 55^s$		Latitudes	$= 48^{\circ}02'10''$
U.C., Aug. 1 a.m.	$12^h 5^m 07^m 18^s$	$N.00^{\circ}44'48''E$.	$= A =$ Reduced azimuth of Polaris	
Hour Ang. east	$9^h 56^m 23^s$	$N.37^{\circ}03'03''E$.	$=$ Indicated bearing of reference mark.	
		$N.37^{\circ}03'30''E$.	$=$ Same, by alt. obsn. on the sun.	
		$N.37^{\circ}03'16''E$.	$=$ Mean.	

Aug. 1: The sun at meridian passage:

Tel. Sun	Watch Time		Observed Vert. Ang.
Rev. $\frac{1}{2}$	$12^h 05^m 43^s$ <u>1 06</u>	Add to sun's center.	$59^{\circ} 40' 30''$
	$12^h 06^m 49^s$ <u>+ 6 11</u>	App. noon Equation of time.	
Dir. $\frac{1}{2}$			$60^{\circ} 11' 30''$
L.M.T.	$12^h 06^m 11^s$		Mean, $v = 59^{\circ} 56' 00''$
Watch fast	$0^m 38^s$		$r = 33$
			$p = +03$
Ditto, the sun, p.m., July 31	$0^m 38^s$	Decol. = $90^{\circ} 00' 00''$ $17^{\circ} 59' 20'' N.$	$h = 59^{\circ} 55' 30''$ <u>$107 59 20$</u>
		Latitude = $48^{\circ} 03' 50''$ By Polaris = <u>$48 02 10$</u>	
		Mean = $48^{\circ} 03' 00''$	

Reduction of the altitude observation on the sun, July 31:

$$\phi = 48^{\circ} 03' 30'' N. \quad \delta = 18^{\circ} 11' 30'' N. \quad h = 30^{\circ} 21' 00''$$

$\cos t = \frac{\sin h}{\cos \phi \cos \delta} - \tan \phi \tan \delta$			$\cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h$			
log	cos	sin	tan	cos	sin	tan
h =	9.825020	9.703533		9.935988		9.767545
$\phi =$	9.825020	10.046452		9.825020		10.046452
$\delta =$	9.977732	9.516697			9.494428	
	9.802752	9.802752	9.563149	9.761008	9.761008	9.813997
		9.900781			9.733420	
nat		.79976	.36972		.54128	.65162
		<u>.36972</u>			<u>.54128</u>	
cos t =	.43004	(+)		cos A =	.11034	(-)

$$t = 64^{\circ} 32'$$

$$A = 8.83^{\circ} 40' 00'' W.$$

$$\begin{aligned}
 &= 4^h 18^m 08^s = \text{App. time of obsn.} \\
 &\quad + 6 14 = \text{Equation of time} \\
 &4^h 24^m 22^s = \text{Local mean time.}
 \end{aligned}$$

Interpolation from tables in the Ephemeris: Polaris obsn.: July 31:

For azimuth.

For latitude.

Hour angle.	Latitude.	Declination.
	48° $48^{\circ} 03' 30''$ 50°	$88^{\circ} 59' 59''$ $88^{\circ} 59' 59''$ $89^{\circ} 00' 10''$
$9^h 46.4^m$	1	$0^{\circ} 50' 37''$ $0^{\circ} 50' 20''$
48.4	47.1	
56.4	44.55	$0 51 43$ $+0 51 35$ $0 51 26$
58.4	43.9	$0 51 57$ $0 51 40$

$$\text{For } \delta = 88^{\circ} 59' 59'' + 0.2$$

$$+ 01'' \text{ Supplemental correction.}$$

$$A = N. 0^{\circ} 44' 48'' E.$$

$$+ 0^{\circ} 51' 36'' \text{ Vert. Ang. correction to elev. of pole.}$$

On Aug. 1 and 2, at about half hour intervals from 8:30 a.m. to 4:45 p.m., I make orientation tests of Buff solar transit No. 19421, including latitude tests by noon observation both days. The tests give a maximum orientation to the right 0'00"; maximum to the left 1'00" (N.0°01'00"W.); the mean of all a.m. tests, 0'25" to the left; the mean of all p.m. tests, 0'45" to the left; the mean of all, a.m. and p.m., 0'38" to the left (N.0°00'38"W.). The tests indicate that a slight improvement can be made to correct the vertical plane of the solar telescope for true parallel with the vertical plane of the transit. The difference is slight, being well within the limit of tolerance (1'30") that is permitted; I defer disturbing the adjustments pending more extended performance tests. The latter, as made by the chief of field party at frequent intervals during the period of the survey, showed normal satisfactory orientation without changing the adjustments.

CLOSING MEMORANDUM

The methods long in use have been developed for the correct operation of the General Land Office solar transit, in which the solar unit is depended upon for a large share of the line running, in combination with observations on the sun, Polaris, and the brighter stars for the more exact determination of time, latitude, and azimuth, where needed. The performance that is required of the solar transit is for uniform orientation, within the usual hours of observation, holding to within 1'30" of the true meridian. The field tests are carried along continually. This is done by comparing the orientation of the solar unit with a carefully determined azimuth line that is based upon a Polaris observation, or by altitude observation on the sun. Various combinations of these methods are employed, and frequently coupled with one or more observations upon a bright star, or stars, within the equatorial belt.

It will be noted that in most of the examples the values in the reductions have been carried to seconds of arc; this is done in order that the final result in azimuth may be reported ordinarily to the nearest even minute. Values in azimuth to the nearest even 30", 15", or 10", are not given in the transcribed field notes unless the nature of the survey and the basic observations justify that refinement.

The field calculations for latitude are always carried to seconds so that successive observations may be compared, usually all reduced to the south boundary of the township, and to have at hand a value to the nearest 30" for setting the latitude arc of the solar unit.

On June 1, 1961, the first of a series of meetings was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project. The first meeting was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project. The first meeting was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project.

APPENDIX A

The first of a series of meetings was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project. The first meeting was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project. The first meeting was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project.

The first of a series of meetings was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project. The first meeting was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project. The first meeting was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project.

The first of a series of meetings was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project. The first meeting was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project. The first meeting was held at the home of the author in the city of New York. The purpose of these meetings was to discuss the progress of the work on the project.

MEMORANDUM

The arrangement of the astronomical data in the Ephemeris¹ that is published annually by the Bureau of Land Management conforms to the methods and examples for the determination of time, latitude, and azimuth, as practiced by the cadastral surveyors; these are set out and explained in the Manual of Instructions for the Survey of the Public Lands of the United States, edition of 1947.

The methods long in use have been developed for the best operation of the General Land Office solar transit in combination with observations on the sun, Polaris, and the brighter equatorial stars for the determination and verification of time, latitude, and azimuth. In this practice the data for the sun are required in terms of the daily apparent positions for the Greenwich meridian; for all stellar data in terms of the Greenwich meridian, mean time, and mean time intervals.

The necessary mathematical tables are carried in the Standard Field Tables² published by the Bureau of Land Management.

The stellar numbers, as 4/6 for Polaris, refer to No. 4 in the list of 28 stars in the Ephemeris of the Bureau of Land Management, and No. 6 in the list of 55 stars published in the American Nautical Almanac.

Key to Symbols

\approx Approximation	v = Observed vertical angle
ϕ Latitude	r = Refraction in zenith distance
δ Declination	p = Parallax of the sun
z Zenith distance	h = Vertical angle corrected for refraction and parallax
A = Horizontal angle counting from the meridian.	t = Hour angle, mean time or sidereal, as required for the equation.

Footnote

²Superintendent of Documents, Government Printing Office, Washington 25, D.C.

The purpose of the investigation was to determine the extent of the damage to the economy of the United States and to the world economy as a result of the war. The investigation was conducted by the War Relocation Authority and the War Relocation Administration.

The purpose of the investigation was to determine the extent of the damage to the economy of the United States and to the world economy as a result of the war. The investigation was conducted by the War Relocation Authority and the War Relocation Administration.

The purpose of the investigation was to determine the extent of the damage to the economy of the United States and to the world economy as a result of the war. The investigation was conducted by the War Relocation Authority and the War Relocation Administration.

The purpose of the investigation was to determine the extent of the damage to the economy of the United States and to the world economy as a result of the war. The investigation was conducted by the War Relocation Authority and the War Relocation Administration.

1. Introduction

- | | |
|-----------------|-----------------|
| 1. Introduction | 1. Introduction |
| 2. Background | 2. Background |
| 3. Methodology | 3. Methodology |
| 4. Results | 4. Results |
| 5. Discussion | 5. Discussion |
| 6. Conclusion | 6. Conclusion |
| 7. References | 7. References |
| 8. Appendix | 8. Appendix |
| 9. Glossary | 9. Glossary |
| 10. Index | 10. Index |